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The Pseudo-sclerotia of Lentinus similis and Lentinus infundibuliformis.

BY

T. PETCH, B.A., B.Sc.

IN 1906, when visiting a rubber plantation (*Hevea brasiliensis*) in which several hundred trees had been felled about two years previously, my attention was arrested by a *Lentinus* which grew under somewhat peculiar conditions on the tops of very many of the decaying stumps. Although the wood of *Hevea brasiliensis* is comparatively soft, stumps of trees which were healthy when felled do not decay rapidly, but produce new shoots, which keep the roots, &c., alive for several years. The continual destruction of these new shoots, either by grazing animals or by man, is ultimately followed by the death of the stump, but the process is a lengthy one.

In the present case the felled trees had been twelve years old, and their stumps, about a foot high, were about ten inches in diameter. The older wood in the centre of each stump was decayed, but the cortical tissues were healthy, practically to the original level, so that each stump top formed a basin which, in the wet weather then prevailing, was filled with a semi-liquid mud consisting chiefly of the residue of the decayed wood. In these basins, either floating or partly embedded in the mud, were masses of wood, from which arose the sporophores of the *Lentinus*.

As will be seen from Plate I., these masses of wood are very variable in size and shape. Some are only about 2·5 cm. long, 2·5 cm. high, and 1 cm. thick; others measure up to 16 × 9 × 8 cms. Some are definitely lenticular, with regular faces and a rounded edge; others are quite irregular. In general, a vertical face follows the vertical grain of the wood, though it does not necessarily follow one tangential plane.

The specimens figured on Plate I. were all taken from stumps of trees *in situ*. The one in figure A shows the vertical grain of the wood, though somewhat obscurely. It is viewed from the inner face, which is irregular, owing to the decay of the matrix to different depths. The ridges which project laterally inwards towards the centre of the figure indicate the different annual rings of the tree, the two which approximate to each other from right and left, respectively, being parts of the same annual ring.

The faces shown in the more regular specimens of figure B exhibit the radial longitudinal section of the original wood, and are slightly vertically grooved owing to the somewhat greater decay of the wood along the zones which contain the large vessels. The top and bottom surfaces of these, which correspond with the cross section of the original tree, also show these grooves, and, in addition, minute parallel grooves at right angles to these, indicating a slightly greater disintegration along the medullary rays.

Figure C of the same plate shows a larger specimen viewed from above. It shows well-marked zones which correspond with the annual rings of the wood, and faint radial grooves corresponding with the medullary rays. Figure D shows the outer face, *i.e.*, the upper in figure C of the same specimen.

The exterior of these masses is always red-brown. The largest I have seen weighed 380 grams when dry (air-dry). When split open they split along the grain of the wood, and at first sight appear to consist of normal unchanged wood, but a microscopic examination reveals the fact that all the elements of the wood are filled with mycelium.

These masses have since been observed on many occasions, and it would appear that they are a normal production in the case of this *Lentinus*, *Lentinus similis* B. & Br., which is usually found on decaying stumps *in situ*. Their formation may be explained as follows. The mycelium of the *Lentinus* attacks and destroys the dead wood, but several portions are left more or less unchanged. When the decayed tissue weathers away, these portions are left embedded in the soil or are washed out by the rain and lie free on the surface. They are filled with a storage form of mycelium, and subsequently

give rise to the *Lentinus* sporophore. They are thus analogous to sclerotia, but their framework consists of wood. It does not appear, therefore, to be unduly extending the idea of the term if we style them pseudo-sclerotia. The sporophore, apparently, always arises from such a pseudo-sclerotium ; when it has seemed to grow from a stump, it has been found on examination to spring from one of these bodies which lies practically free in the surrounding decayed tissue.

Figure C shows that the selective action of the fungus in forming these pseudo-sclerotia is not correlated with any particular region of the wood. In that particular example the body of the mass is composed of the outer wood of the stem, but the radially projecting limb penetrated almost to the centre of the tree. On the other hand, the markings on the surface of the pseudo-sclerotia indicate a slightly more advanced destruction along the medullary rays and the annular zones which contain the large vessels.

von Schrenck (11), in describing the destruction of the wood of *Prosopis glandulosa* by *Polyporus texanus* (Murrill) Sacc. & Trott., states that the fungus does not destroy the wood as a whole, but attacks only the heavily lignified groups of wood fibres. Although the wood parenchyma and the vessels are filled with hyphæ, they resist destruction almost completely. This he attributes to the high tannin content of both these tissues. The finding that tannin exerts a retarding influence on the development of certain fungi was published by the present writer (7) in dealing with *Thielaviopsis paradoxa* in 1909, and it has since been extended to other species by other investigators. But it is evident that this cannot be invoked to explain the formation of the pseudo-sclerotia of *Lentinus similis*, since the latter may include elements of all the regions of the stem.

Rough determinations of specific gravity, made from determinations of gross volume and weight, gave the following results. In normal *Hevea* wood from a tree twelve years old, taken midway between centre and circumference, the specific gravity was 0·66. A pseudo-sclerotium from *Hevea* wood, which had apparently not yet produced a sporophore, had a specific gravity of 0·65. A small pseudo-sclerotium

which had borne three sporophores had a specific gravity of 0·41.

When cut with a razor, the tissue of the pseudo-sclerotium is found to be softer than normal *Hevea* wood. As a general rule, all the elements of the wood are present, but the walls of the fibres and of the cells of the medullary rays are reduced in thickness. The wall of the fibre in normal *Hevea* wood attains a thickness of 6 μ ; walls of this thickness may be found in the pseudo-sclerotia, but most of them are considerably reduced, in some cases to a thickness of about 1 μ, and here and there one finds a " pocket " where the fibres have disappeared, though the latter occurrence is comparatively infrequent. In some cases some of the cells of a medullary ray have been destroyed.

In chlor-zinc-iodine the tissue stains yellow-brown. Closer examination of longitudinal sections reveals a thin violet layer lining most of the fibres. This layer is frequently dragged out of the cell in cutting free-hand sections, and is then conspicuous, but it is so thin that it is not discernible in cross section. The vessels of the wood and the cells of the medullary rays do not show any blue lining.

It may be noted that in the sap wood of a healthy *Hevea* the fibres show a thick cellulose lining, which stains violet with chlor-zinc-iodine. This swells up in the stain, separates from the yellow-brown wall, and lies irregularly distorted (in cross section) within the lumen of the fibre. The appearance is then exactly that figured by Marshall Ward in his paper on *Stereum hirsutum* (13). Ward states that he used the sap wood of *Æsculus*, and he attributes the inner cellulose layer to the action of the fungus, while he gives a complete account of the difference in growth of the fungus on the sap wood, on which it was luxuriant, and on the heart wood, on which the growth was scanty. It would appear possible that the better development of the fungus on the sap wood was due to the presence of a lining of cellulose in the fibres, suitable for the nourishment of the fungus, prior to infection, not to a more rapid delignification of the wood by the fungus.

In the case of a pseudo-sclerotium, the wood of which extends from sap wood to heart wood, such as that shown

in figures C and D, Plate I., there is a noticeable difference between the heart and sap wood when stained with chlor-zinc-iodine. The violet colouration occurs here and there in the heart wood, but to a much less extent than in the fibres in the sap wood. Even in the heart wood, however, the thickness of the walls of the fibres is reduced, though to a less degree than in the sap wood.

The conclusion would appear to be justified that the fungus has partly destroyed the walls, more in the sap wood than in the heart wood, and that the cellulose lining which stains violet is due to the action of the fungus and is not a residue of the original cellulose lining of the sound fibres.

In aniline chloride all the walls stain yellow, the colouration being most intense in the medullary rays and the vessels. There is marked difference, macroscopically, between the colour of the sap wood and that of the heart wood in the pseudo-sclerotium when stained with aniline chloride, the colouration being much more intense in the heart wood.

With phloroglucin, the vessels and the medullary rays stain pink, whether the pseudo-sclerotium is formed from sap wood or heart wood. The colouration of the fibres varies. If the wood is sap wood, the fibres stain here and there, often in short isolated lengths of the wall of a fibre, the remainder being unstained ; but in general the fibres do not stain, and the contrast between the vessels, medullary rays, and fibres is exceptionally well marked. In the heart wood region of the same pseudo-sclerotium the fibres in general are stained by phloroglucin, but the colouration is paler than in normal *Hevea* wood ; in the thicker walls the colouration is deep rose-red along the middle lamella, the next layers being paler, with sometimes a very thin colourless layer lining the cell ; the thinner walls are uniformly coloured pale pink, often with a deep rose-red patch at the junction of the middle lamellæ of the walls of adjacent cells, but some may be quite colourless.

The débris of the wood surrounding the sclerotium consists of fragments of the medullary rays and the vessels. In some cases the walls of the cells of the medullary rays are reduced to the middle lamella only, but the majority retain some of the thickening layers, though much reduced, and show the

usual pitted structure. In normal *Hevea* wood these walls range from 4 μ to 8 μ in thickness; in the fragments of the decayed wood they may be 2 μ to 4 μ in thickness, and these may be continuous with the remains of the walls of adjacent cells which have been reduced to the middle lamella only. The débris stains yellow with chlor-zinc-iodine, but gives no colouration with phloroglucin and hydrochloric acid, nor with aniline chloride.

The whole of the tissue of the pseudo-sclerotium is filled with the hyphæ of the fungus. These hyphæ, when regular, vary from about 6 to 8 μ in diameter. They form a tangled mass in the medullary rays and the vessels, but run longitudinally along the fibres. If the hyphæ in the fibres are regular, several occur crowded in the lumen of a single fibre, and these intertwine in a long spiral. But in general the hyphæ in the fibres are irregular, swelling out to a diameter of 12 μ or so, in lengths up to 50 μ long, or producing a succession of irregular inflations. Frequently a hyphæ swells out into a globular mass which completely blocks the cells. The walls of these hyphæ are strongly thickened (except at the periphery of the pseudo-sclerotium), and the lumen in cross section appears as a mere point. In their irregular character and thickened walls the hyphæ strongly resemble those of a sclerotium. In the cells of the periphery of the tissue the hyphæ are, as a rule, thin-walled and collapsed.

In general shape the various parts of the hyphæ resemble those of the sclerotium of *Lentinus Woermanni* Cohn et Schroet. as figured by Bommer (I. Pl. I., figs. 10–26), or the simpler forms from *Pachyma cocos* figured by the same author (I. Pl. IV., figs. 5, 6). They resemble these, too, in being very strongly refringent, but differ in that, in general, it has not been possible to observe the existence of a central cavity through the tubercular parts of the hyphæ by external examination. Cases in which the lumen appears as a darker line do occur, but they are not common.

The hyphæ do not swell in caustic potash; in that respect they differ from the tubercular thickened hyphæ of *Pachyma cocos* as described by Fischer (3). They are not stained by chlor-zinc-iodine, nor by iodine in potassium iodide. The

following stains have been tried without effect: Congo red, eosin, Delafeld's hæmatoxylin, methyl green, picric aniline blue, safranin, sudan III., methylene blue.

Fischer found that in the sclerotium known as *Pachyma cocos* three forms of hyphæ were present. The first were of normal shape, 2–4 μ diameter, but with a strongly thickened wall, so thick that the lumen was reduced to a minimum. These swelled slightly in caustic potash, and were not stained by safranin, methyl green, methylene blue, or Congo red.

The second form, which constituted the chief constituent of the sclerotium, consisted of irregular coralloid bodies, which were determined by Fischer to be hyphæ modified by the deposition of reserve substances in their walls. These dissolved in caustic potash, with the exception of the outer layer of the hypha. These bodies were not stained by chlor-zinc-iodine nor iodine. They stained strongly with methylene blue, or Congo red, or methyl violet, but not with methyl green or safranin.

The third constituent of *Pachyma cocos* consisted of larger oval refractive bodies, in which an evident lamination could be observed. These gave the same reactions as the second.

Judged by their shape the hyphæ in the pseudo-sclerotia of *Lentinus similis* correspond with the first two constituents of *Pachyma cocos*, but it will be seen that the reactions of the hyphæ of *Lentinus similis* correspond with those of the normally-shaped hyphæ of *Pachyma cocos*, not with the abnormally thickened constituents of the latter. I have not been able to consult Cohn and Schroeter's paper on *Lentinus Woermanni*, but, according to Bommer (1), the thickened elements of its sclerotium dissolve in caustic potash.

The red external colour of the pseudo-sclerotium is due to an amorphous deposit in the lumina of the fibres, &c., which open to the exterior. It is apparently homologous with the deposit frequently found, usually in black sheets, in wood attacked by various species of Pyrenomycetæ. von Schrenck (12) describes a brown substance found limiting the decayed wood of lilac attacked by *Polyporus versicolor*, which he states results from the drying up of a yellow-brown liquid which fills the cells, and probably consists of decomposition products

which are infiltrated into the sound wood immediately in advance of the fungus.

The action of the mycelium of *Lentinus similis* on the wood appears to be identical with that of *Stereum hirsutum* as described by Ward (13). The wood is attacked from the interior of the cell towards the middle lamella, being first delignified and then consumed. The most notable difference lies in the selective action of the fungus, the fibres being delignified earlier than the medullary rays or the vessels.

One fact already recorded appears to conflict with the finding that the fibres are first destroyed, *i.e.*, the formation of furrows on the pseudo-sclerotium, in some cases, along the zones which contain the larger vessels. This apparent contradiction is explained when the furrows are examined carefully. It is then seen that the ends of the vessels project slightly above the general level at the base of the furrow (which is about 0·25 mm. deep), and that the furrow is due to the more advanced destruction of the fibres surrounding the vessels.

But the special feature which appears to make the case of *Lentinus similis* worthy of record is the reservation of certain regions of the wood which is attacked by the fungus as storage tissue and base for the development of sporophores. Nearly the whole of the wood is quite destroyed, only the delignified remains of the medullary rays and vessels being left. But in some regions the wood is only lightly attacked, some layers of the walls being removed, but more than sufficient left to maintain the appearance, structure, and solidity of ordinary wood. These parts are filled with the hyphæ already described, and from them the sporophore subsequently arises.

I have not been able to determine that any further change occurs in the woody skeleton of the pseudo-sclerotium when the fructification develops. It would seem probable that the fructification is developed solely at the expense of the storage hyphæ, and that the latter do not further attack the wood. The question is somewhat indeterminable, as the isolated pseudo-sclerotia are attacked by other fungi, as well as by bacteria and insects, in the field.

As has already been noted, the red limiting layer of the pseudo-sclerotium resembles the black layers found so frequently in wood attacked by Pyrenomycetæ. The opinion seems to be current that in the latter instances the black layer indicates the limit to which the mycelium of the fungus has advanced. That view would appear to be untenable in the present case ; the enormous development of thick-walled mycelium and the comparatively slight destruction of the wood preclude the suggestion that the remainder of the tissues have been destroyed by some other agency.

Some features in the supposed course of development of *Pachyma cocos* would appear to bring it into relationship with the pseudo-sclerotium of *Lentinus similis*. *Pachyma cocos* is a subterranean sclerotium which is frequently found united to the roots of trees. The relationship between the root and the fungus has been described by Fischer (3), from whose account the following details are taken. In an example in the Herbarium of the British Museum, the strongly developed *Pachyma* sclerotium was seated on a fairly thick root and surrounded by a dark rind. In a cross section the wood of the root appeared intact. There was no *Pachyma* mass within the wood, but it was situated between the wood and the cortex, the latter forming the outer dark rind. In a specimen at Kew the white *Pachyma* mass was not limited to the space between the wood and the cortex, but had attained a fair development within the wood ; the greater part of the wood had been replaced by hyphæ, but in cross section it was seen that wedges of wood remained, projecting inwards from the periphery. In a third specimen a cross section showed that nearly the whole mass consisted of fungus hyphæ, and only traces of wood remained ; the latter consisted of scattered groups of cells towards the periphery, and a great number of isolated discoloured fibres in the central parts.

Microscopic examination showed that the *Pachyma* constituents were not confined to the white masses which to the naked eye were obviously of fungus origin, but that these were present also within the cells of the apparently sound wood. They occurred in all the elements of the wood ; in the majority of the sections hardly a single cell could be

found in which they were lacking. In the larger remnants of the wood it was not possible to detect any action of the fungus on the cells, and as far as could be decided without a comparison with sound wood of the same species, the wood filled with *Pachyma* hyphæ was quite normal. But where small wedges of wood remained between large masses of *Pachyma*, a destruction of the cell wall had evidently taken place; these walls were quite thin, the discoloured thickened membrane having almost quite disappeared. The fungus destroyed the inner thickening layer of the cell wall, and only the middle lamella remained.

Fischer describes the action of *Pachyma cocos* on the wood as follows. The hyphæ enter the root tissue as normal hyphæ, and spread through the wood and the cortex. There they are modified, being changed by the deposition of reserve food into highly refractive, irregular, coralloid bodies, whose shape is determined by the size of the cells in which they happen to lie. The walls of the cells are attacked by the fungus, the thickening layers being first consumed, and finally the middle lamella, so that ultimately a mass of almost, or quite, pure fungus tissue is left in the place of the wood.

It would appear that in the case of *Lentinus similis* we have a process similar to that described above, but the action does not proceed so far. The cells of the wood are filled with thickened coralloid hyphæ, and the walls of the cells are partly consumed, but the destruction does not proceed to such an extent that the whole of the wood is replaced by fungus hyphæ.

Lentinus infundibuliformis B. & Br.

A somewhat similar pseudo-sclerotium is formed by another common Ceylon *Lentinus*, *L. infundibuliformis* B. & Br. In this case the decayed wood *may* weather away leaving a compact body, but more usually there is a considerable mass of partly decayed wood outside the reddish limiting layer of the pseudo-sclerotium. In general, therefore, it is not so definite as that of *L. similis*, but often has the appearance of merely a piece of decayed wood. These pieces, however, persist, after the bulk of the log attacked has decayed, and

subsequently produce the fructification. But the formation of such masses is apparently not constant in the case of *Lentinus infundibuliformis ;* the sporophore frequently, perhaps the more usually, develops directly from the decaying log or stump.

The two examples described below were formed from the trunk of a mango tree which was felled in December, 1904. The log remained recognizable until 1914, and during the ten years it produced successive crops of this *Lentinus* and other fungi.

A pseudo-sclerotium was gathered in 1912,* lying free on the soil by the side of the decaying log. It bore two pilei of *Lentinus infundibuliformis*, one-half expanded and the other just expanding. In shape it is irregularly fusoid, 19 cm. long and 4 cm. diameter at the thickest part. It is more or less irregularly longitudinally furrowed, and has the general appearance of a piece of wood. Externally it shows the grain of the wood, and is coloured a reddish-purple. On handling the air-dry specimen one is immediately struck by its weight ; its specific gravity is 0·87.

On splitting it longitudinally with a chisel, the fracture does not follow the grain of the wood. The surface of the fracture is granular or powdery, with lines here and there showing the remains of the wood fibres. In cross section (sawn) the surface appears waxy or resinous, and composed of closely-packed circular elements, but when smoothed with a razor it is uniformly continuous, the position of the medullary rays and vessels being indicated by whiter lines and dots, which are only apparent under a lens. This pseudo-sclerotium differs from that of *Lentinus similis* in that it is solid, all the cavities of the wood elements being completely filled by the mycelium.

Examination of a cross section shows that much of the wood persists. The medullary rays have disappeared. Many of the vessels have also been consumed, but a number of them remain ; their walls are much reduced, and they often lie isolated in the mass of mycelium. The bulk of the woody

* Another pseudo-sclerotium of this type was obtained at the same spot in March, 1915.

skeleton, however, consists of the remains of the fibres ; these occur in extensive patches, on the whole fairly continuous, but often broken up and forming zigzag lines, composed of single walls of adjacent fibres. In some places all the fibres have been consumed and the cavity is filled with mycelium ; in others the thickened angles of the fibres remain isolated and embedded in the mass of mycelium. Where the fibres form a continuous network, their walls are much reduced, sometimes to the middle lamella, but in general the remains of the walls are about 4 μ thick.

With chlor-zinc-iodine the remains of the vessels and fibres stain yellow-brown ; no trace of blue was observed. With phloroglucin and hydrochloric acid all the remains of the wood stain rose-pink, even in the places where only the corners of the fibres persist, and there is no evident increase in intensity of colouration from the exterior to the middle lamella. Thus, the remains of the fibres are not delignified.

The action of *Lentinus infundibuliformis* on the wood thus agrees with that of *L. similis*, in that the wall is attacked and consumed from the lumen of the cell inward towards the middle lamella, but it differs in that the medullary rays and vessels are the first elements to disappear.

In longitudinal section the walls of the fibres are found to be discontinuous ; this accounts for the irregular fracture in that direction.

As already stated, the mycelium completely fills all the elements of the wood, or the spaces where these have been consumed, and forms with the remains of the wood one solid mass. Where the wood elements have disappeared, the mycelium which originally filled the lumina retains the outlines of the latter to a great extent. This is specially noticeable in the case of the vessels. Three elements may be distinguished in the mycelium. The least numerous are thin-walled, normally-shaped hyphæ, 2–3 μ diameter, with evident protoplasmic contents. More abundant than these are other normally-shaped hyphæ of the same uniform diameter, but refringent, rigid, with thickened walls. These latter predominate along the sites of the medullary rays ; they frequently bear small globose bodies, resembling conidia in

appearance, about 2 μ diameter, on short lateral pedicels about 2 μ long, perpendicular to the hypha. The remainder of the mycelium is composed of inflated, irregularly nodular, "coralloid" hyphæ, up to 12 μ diameter, which bear short, thick branches often inflated above, and subglobose swellings. In cross section it is seen that the walls of these hyphæ are laminated and thickened, the cavity varying from about 4 μ in diameter to a mere point. The "coralloid" hyphæ apparently adhere to one another, but separate on heating with dilute caustic potash.

The whole of the mycelium swells in caustic potash, but the swelling is most marked in the case of the irregular coralloid hyphæ; the walls of the latter, however, do not dissolve. Iodine in potassium iodide gives a faint yellow colouration, as does also chlor-zinc-iodine. Watery methylene blue stains the regular hyphæ slightly, but the irregular hyphæ more deeply. All stain with Congo red, but not with eosin. With picric aniline blue, or cotton blue, the thin-walled regular hyphæ stain deeply, but the remainder takes a very slight, or no, tinge.

A second pseudo-sclerotium was obtained from the same spot in 1914. This consisted of a subfusoid piece 23 cm. long and 7 cm. diameter, originally wood, to which was attached a piece of bark 16 cm. by 13 cm. It bore twenty-three pilei of the *Lentinus* in different stages of development, arising chiefly from the bark or at the junction of the bark and the wood. The surface of the wood is weathered and irregularly split, and has almost completely lost its red colour. It is very friable when sawn, and splits irregularly. Its weight is in marked contrast to that of the previous specimen, its specific gravity being only 0·28. In the absence of any previous knowledge of those structures, it would appear to be merely a piece of semi-decayed wood.

Microscopic examination shows that the cells of the medullary rays have in some places disappeared, while in others they persist with their walls much reduced in thickness, or corroded and fragmentary. The vessels, as a rule, remain, but their walls are reduced in thickness. The fibres on the whole persist, in some cases with walls reduced to the middle

lamella, elsewhere with walls 4 μ or more thick. The greatest reduction of the fibres occurs in the "spring wood"; in the autumn wood they often appear quite sound. Where considerable reduction has occurred, the walls of the fibres are perforated with large irregular openings.

Chlor-zinc-iodine stains all the remains of the wood brown to yellow-brown: no blue was observed. With phloroglucin and hydrochloric acid the fibres and vessels stain, but the medullary rays do not: the contrast in the stained cross section is most striking. Occasionally, where a rather thick wall of a cell in a medullary ray has been left, this stains with phloroglucin. In the autumn wood the walls of the fibres stain uniformly with phloroglucin, but in the spring wood they exhibit differential staining, the colour becoming more intense towards the middle lamella.

The action of the fungus on the wood thus agrees with that found in the previous case: the medullary rays are attacked, or at least destroyed, first, and then the vessels and fibres. But the destruction of the wood has not proceeded so far as in the case of the pseudo-sclerotium of this species first described.

With regard to the amount of the fungus tissue present, however, this example differs widely from the former. The vessels and the medullary rays (or the sites of the latter) contain numerous interlacing hyphæ, but there are comparatively few in the fibres. In no case do the hyphæ completely fill the lumina of the cells. The first sclerotium was a solid mass of mycelium in which the remains of the wood were embedded; the second, in the condition as gathered, is a piece of decayed wood containing comparatively little mycelium.

The mycelium consists of two elements only. One of these consists of the thin-walled hyphæ previously noted, the other of the rigid thick-walled, regular hyphæ, about 2 μ diameter, bearing the globose conidia-like bodies described above. No coralloid hyphæ have been found, but the cells contain amorphous masses, in comparatively small quantity, which, like the globose conidia-like bodies, stain yellow-brown with iodine in potassium iodide. The reactions of the two

elements of the mycelium to various stains are identical with those previously described for these two in the case of the former example. The conclusion would appear to be justified, that these amorphous masses are the remains of the coralloid hyphæ which have been exhausted of their reserve food by the growth of the pilei. This second example is an exhausted pseudo-sclerotium. It would also appear probable that the coralloid hyphæ are produced by the transformation of the thick-walled normal hyphæ, and that the conidia-like bodies are a first stage in the formation of the short side branches.

The pseudo-sclerotium of *Lentinus infundibuliformis* bears a much closer resemblance than that of *L. similis* to *Pachyma cocos*. Its " coralloid " hyphæ are more highly and more abundantly developed, and form with the remains of the wood a solid mass; whereas in the case of *L. similis*, the hyphæ, in general, lie free in the lumina of the wood elements. But in neither case has it been possible to demonstrate that the thickened hyphæ dissolve in caustic potash.

General.

The existence of sclerotia in the genus *Lentinus* has long been known. One of the sections into which Fries divided the genus *Lentinus*, *Scleroma*, contained those species which arose from a sclerotium or from a mass of mycelium in the soil. F. S. Earle (2) narrows Fries' *Scleroma* by including only those species which have a true sclerotium, and limits the genus *Lentinus* to these, with the type specimen *Lentinus tuber-regium*.

There seems to be considerable doubt as to the identity of *Lentinus tuber-regium*. It was originally described and figured by Rumphius (10) from the Moluccas. Rumphius associated it with the sclerotium *Pachyma tuber-regium*, but Fries states that its mycelium merely binds the soil together, and is clearly different from the *Pachyma*. In " Epicrisis Systematis Mycologici " (1836–38) Fries stated that he had not seen it, but in " Novæ Symbolæ Mycologicæ " he wrote that it occurred " *Ad terram in insulis Archipelagi indici, sat frequens.*"

Hennings (5) stated *Lentinus tuber-regium* occurred in the Moluccas, Madagascar, and the Cameroons, and formed a large sclerotium, which was eaten by the natives as a medicine. His figure much resembles *L. infundibuliformis*.

Recent records of *Lentinus tuber-regium* appear to refer chiefly to Africa. Eichelbaum (2A) recorded it from East Africa, and stated that it did not form a true sclerotium, but merely bound the earth together into a ball ; it was not the sclerotium, but the pileus, which was eaten by the natives.

The question has recently been discussed by Ramsbottam (9), who identified eight specimens brought from Nigeria by Mr. and Mrs. P. A. Talbot as this species. Only in one case was there a perfect sclerotium, and that bore nine fruit bodies. The microscopic structure of the sclerotium was exactly similar to that described by Schroeter and Bommer for *L. Woermanni*. Ramsbottam states that *Lentinus flavidus* Massee, from Old Calabar, which also grows from a sclerotium, is identical with the species from Nigeria examined by him. He concludes that " the plant which was described by Rumphius, and so long lost sight of, is fairly common in West Africa, and it is probable that *L. Woermanni* Cohn and Schroet., and certainly that *L. flavidus* Massee, are merely stages of the same fungus." One would, however, prefer to have specimens from the East Indies, where it was said to be common, before accepting this decision.

However, no doubt exists in the case of the other species. *Lentinus Woermanni* Cohn and Schroet., which has frequently been found in West Africa, arises from a true sclerotium which has been adequately described and figured by Cohn and Schroeter and Bommer (1). *Lentinus scleroticola* from Samoa was described by Murray (6), who considered that it was parasitic on the sclerotium, an opinion which has not been shared by others who have examined the specimen. *Lentinus cyathus* Berk. and Broome, from Queensland, also arises from a sclerotium. Ramsbottam states that *L. scleroticola* and *L. cyathus* are quite distinct from one another and from *L. tuber-regium*.

In addition to species which possess a true sclerotium there would appear to exist others whose mycelium merely

binds together earth in a large compact mass. This is vouched for in recent times by Eichelbaum, but detailed accounts of the structure of any such mass connected with a *Lentinus* have not, so far as I am aware, been published.

Lentinus similis and *Lentinus infundibuliformis* provide a third type in which the skeleton of the pseudo-sclerotium consists of the wood of the host plant.

Whether these three types are definitely associated with different species of *Lentinus*, or whether they are merely stages which may be assumed by the sclerotium of any one species, must remain an open question on the available evidence.

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Description of Plate I.

FIG. A.—Pseudo-sclerotium of *Lentinus similis*, with *Lentinus* growing from it : irregular.

FIG. B.—Three pseudo-sclerotia of *Lentinus similis*, subangular or rounded.

FIG. C.—Pseudo-sclerotium of *Lentinus similis* viewed from above. Considered in relation to the tree, this upper surface corresponds with the cross section of the stem. The projecting portion on the right is directed radially. The furrows from left to right are the result of a greater decomposition along the zones which contain the vessels.

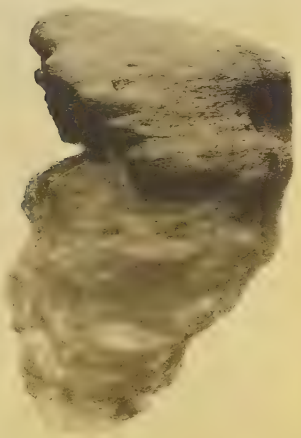
FIG. D.—The same pseudo-sclerotium as in C, viewed from the outer side.

A

B

C

D



PSEUDOSCLEROTIA OF LENTINUS SIMILIS X 2/5

Further Corrections and Additions to Trimen's "Flora of Ceylon," 1893–1911.

BY

J. C. WILLIS, Sc.D., F.L.S.

IN a paper in this journal, Vol. V., Pt. III., Dec., 1911, p. 175, was published a list of corrections and additions to the Flora of Ceylon. In going over my botanical notes I have come upon a few sheets on this subject which escaped incorporation in that paper, and give them now in alphabetical order of genera :—

Achyranthes bidentata (III. 404). Fl. Feb.

Aganosma cymosa (III. 139). To 4,500 feet.

Alternanthera triandra (III. 405). Haputale, 4,500 ft.

Amomum involucratum (IV. 250). Heads sometimes on leafy stems.

Aneilema zeylanicum (IV. 305), *for* var. longiscapa *read* longicapsa.

Arisæma Leschenaultii (IV. 352). The spathe may be only 3 in. long. Fl. Jan.

Asystasia chelonioides (III. 324). Leaves sometimes much narrower than described.

Carex filicina (V. 110). Epiphytic on Pedurutalagala at 7,500 ft.

Casearia coriacea (II. 237). Leaves sometimes 1–1¾ in.

Cassia Kleinii (II. 110). Leaves sometimes only ¼ in. long.

Celosia pulchella (III. 393). Fort Macdonald valley, 4,600 ft.

Coleus barbatus (III. 373). Bandarawela specimens have the venation very prominent beneath and impressed above.

Crepis japonica (III. 51). The leaves may be slightly hairy.

Crotalaria albida (II. 12). Hakgala, 5,500 ft.

Cyanotis zeylanica (IV. 313). Hakgala, Ambawela.

Dædalacanthus montanus (III. 297). Top of Ritigala.

Desmodium heterophyllum (II. 55). Leaflets sometimes not more than $\frac{1}{4}$ in.

D. Scalpe (II. 50). Terminal leaflets sometimes $1\frac{1}{4}$ in., lateral 1 in. or less.

Dimeria fuscescens (V. 198). Nodes very commonly hairy.

Euphorbia thymifolia (IV. 8). Talawakele, 4,000 ft.

Ficus glomerata (IV. 96). Hakgala, 5,200 ft.

Freycinetia Walkeri (IV. 342). Fl. Apr.

Leucas biflora (III. 386). Ritigala.

L. marrubioides (III. 385). Hairs sometimes ascending.

Lippia nodiflora (III. 347). Craig, Bandarawela, 4,500 ft.; a smaller plant with smaller leaves.

Loranthus tomentosus (III. 465). Corolla tube $\frac{3}{8}$–$\frac{5}{8}$ in.

Macaranga indica (IV. 70). Adam's Peak, with leaves glabrous below.

Mallotus albus (IV. 64). Diyatalawa, 4,000 ft.

M. Walkeræ (IV. 66). Fort Macdonald valley, 5,000 ft.

Ophiopogon intermedius (IV. 266). Fl. Jan.

Phaseolus trinervius (II. 72). Leaflets sometimes $1\frac{1}{2}$ in.

Pogonatherum crinitum (V. 222). Peduncles often to 3 in. long. Glume III. usually absent.

Polycarpæa spicata W. & A., *cf.* Willis in Ann. Perad., V., 167. A species new to the Ceylon flora.

Polystachya zeylanica (IV. 182). Hakgala, 5,500 ft.

Rubus lasiocarpus (II. 138). Rachis sometimes up to $6\frac{1}{2}$ in.; leaflets sometimes almost glabrous beneath; fruit sometimes blue.

Spermacoce hispida (II. 371). Patana, Fort Macdonald valley, 4,700 ft.

Smilax prolifera (IV. 283). Ditto.

Stenosiphonium Russellianum (III. 298). Top of Ritigala.

Strobilanthes Nockii (III. 301). Ambawela road, 5,500 ft.

S. pulcherrimus (III. 315). Sita Eliya.

S. vestitus (III. 310). Hakgala.

Zornia diphylla (II. 35). Pods on the same plant may be spiny or not spiny.

Some Abnormalities of the Coconut Palm.

BY

T. PETCH, B.A., B.Sc.

IN the following notes are described some abnormalities of the coconut palm which have come under the writer's notice during the last few years. In general, the phenomena described have been recorded before, but it is possible that the present account may contain additional details which may be of some service.

Yellow Coconuts.

In the "Tropical Agriculturist," Vol. IX., page 102, there appears the following paragraph, entitled "A Curious Coconut Tree":—

> A gentleman who was down at Matara the other day tells us of a curious coconut tree he observed on the roadside a few miles beyond Galle, which bore ordinary coconuts on one side and king coconuts on the other. Though he has been travelling about the Island for a good many years he does not remember either seeing or hearing of a similar case before. Neither do we, and we should be glad to hear more about the history of this curious tree.

The editor's evident scepticism was dispelled by the receipt of a bunch of coconuts from the same (?) correspondent, together with the following letter ("Tropical Agriculturist," Vol. X., page 650):—

> Herewith a bunch of coconuts with three fruits, two of which you will find are like the king coconuts, while the other is quite green, all in the same cluster, and from a tree about forty years old, which hitherto never had anything but green-coloured nuts, and has about four clusters at present all green-coloured. One nut you will note is small; this is, I believe, attributable to rats making an attempt when the fruit was tender to eat it. There were two other green-coloured nuts on the same cluster, which unfortunately were destroyed by rats in their early stage.

It will be noted that this specimen bunch differs from those first described, in having green and yellow coconuts on the same inflorescence; whereas the tree referred to in the former paragraph was said to have ordinary (*i.e.*, green) coconuts on

one side and king coconuts (*i.e.*, yellow) on the other, that is, on different inflorescences.

In 1913 a similar instance was brought to our notice by Mr. L. G. O. Woodhouse. Great interest had been excited among the inhabitants of the village of Dambadeniya, North-Western Province, by the occurrence on the same coconut palm of green and yellow nuts. They declared that it bore two different kinds of coconuts, yellow or *gon-tembili* and green or *pol*. Some bunches bore green fruit only, others yellow fruit only, while others bore the two kinds intermingled. No information is available as to the colouration of the leaves.

The specimen bunch sent bore five nuts, three green and two yellow. The main stalk of the inflorescence was longitudinally striped green and yellow. The side branches which arose from the green areas were green and bore green fruit, while those which sprang from yellow areas were yellow and bore yellow fruit.

Two nuts of each colour were planted. Only two of the four germinated, but fortunately one of each kind. The first leaves produced by the yellow nut were decidedly yellowish, but subsequent leaves became greener, and the plant now, at the age of one year, bears leaves which are green with a yellow or bronze midrib. Its leaves, however, are a paler green than those of the sister plant. At first it was notably smaller than the other, but the difference has decreased as the plants have grown older. It is now not quite as tall, and still produces smaller leaves.

The fruits were narrow and elongated, with well-marked angles. The classification of coconuts is in an unsatisfactory state, and the native classification depends chiefly on colour and shape. Other factors are sometimes recognized, for example, the thickness of the shell—a specially thick-shelled nut being valued for its use in a native game, in which one player attempts to break the other's nut, as English boys play with horse chestnuts. But to what extent these characters are heritable and constitute distinct varieties has never been determined.

The occurrence may, perhaps, be included under the assemblage of phenomena known as chlorosis, which is now gradually yielding to analysis. As the main stalk of the

inflorescence bears the yellow colour, it is not due to any effect of fertilization on that particular bunch. It is hoped to grow the two palms to maturity, and it may be possible that they will ultimately throw some light on the origin of yellow varieties of coconuts.

Double Coconuts.

As is generally known, the ovary of the coconut is initially trilocular, but only one loculus develops; the other two are, as a rule, suppressed at an early stage, the process usually being evident when the young fruit is about an inch or an inch and a half in length. Evidence of its trilocular origin is, however, always present in the three micropylar orifices of the nut.

All coconut planters are well acquainted with "double" coconuts, *i.e.*, fruits in which two loculi have developed, and some state that trilocular nuts are sometimes found. I have not seen an example of the latter, but the former are fairly common. When the husk is removed, the bilocular nut, in the cases I have seen, betrays its abnormal internal structure by its shape, it appearing laterally compressed.

One example in my possession measures 4½ inches in length, 4 inches in breadth in one direction, and 3¼ inches in breadth in the direction perpendicular to the former. Of the three external longitudinal ridges, one runs down the middle of one of the flatter sides, while the other two diverge more or less symmetrically from this median ridge at angles of about 120°. The median cross section of the nut is an ellipse, with its major axis 4 inches and its minor axis 3¼ inches.

The nut is completely divided into two by a longitudinal partition perpendicular to the flatter sides, and forming the minor axis of the ellipse of cross section. The partition is even, except for a slight bulge to one side in the lower half. It is composed of the same elements as the external shell, but is much thinner. The external shell is from 3 to 4 millimetres in thickness, while the partition is only 0·75 to 1 mm. It becomes thicker as it meets the outer shell, and rounds off into the latter. On the one side it arises along a line which corresponds in position with the external ridge, and meets the other side midway between the positions of the other two

ridges. Where it meets the latter side there is a small cavity in the outer shell of the nut, which apparently indicates the third loculus. In cross section this cavity is one centimetre in length (measured along the outer shell) and one and a half millimetres broad; it is almost filled with a comparatively soft, brownish-white tissue.

The endosperm of both loculi was normal. The usual three micropylar orifices are present, two of them normal and symmetrically situated, one on either side of the partition, while the other is situated over the partition and is blocked by it.

A second specimen is almost identical with that already described. Its shape, the position of the external ridges, the nature of the micropylar orifices, the line of origin of the partition, and the indication of the third loculus are all exactly the same as in the previous example. Its median cross section is an ellipse, whose major axis is $4\frac{1}{2}$ inches and minor axis $3\frac{3}{4}$ inches. The partition, however, does not coincide with the direction of the minor axis, but curves strongly to one side, so that the cross section of one loculus is a circle, a little more than 3 inches in diameter, while that of the other is a lune, about an inch broad in the middle. Both loculi contained normal endosperm.

A different kind of "doubleness" was brought to my notice in 1914 by a specimen, which the finder had considered sufficiently strange to be worthy of exhibition at the Matara Agricultural Show. It consists of two nuts developed within the same husk.

The specimen is $5\frac{1}{2}$ inches in length. The two nuts are unequally developed, and neither is normally shaped. In median cross section the larger shows a segment of a circle rather greater than a semicircle, its flat side being 4·9 inches long and its breadth, in the perpendicular direction, 3 inches; while the smaller is approximately a semicircle, 3·8 inches along the flat side and 2·6 inches broad in the perpendicular direction. The two nuts lie with their flat faces opposed to one another, and separated by a layer of coir (tissue of the husk) from 2 to 6 mm. in thickness. Their angles are rounded off, so that a broad fissure runs down each side of the double nut. The curved parts of the walls of the two nuts are of normal

thickness, but the flat opposed faces become very thin in the middle, where the hard dark brown tissue vanishes, and the wall consists of the inner pale brown layer only.

In the larger nut two of the external ridges form the edges of the flat side, while the third divides the hemisphere unequally at about one quarter of its breadth. The micropyle on the larger segment is normal ; that on the smaller segment is about the normal size, but is oblique and blocked ; the third, which is also oblique and blocked, is very small, and is situated just below the ridge on the flat side. In the smaller nut only one micropyle is present ; that is normal and symmetrically placed.

Prolification

Leafy prolification of the inflorescence is said by Masters ("Vegetable Teratology," page 165) to occur in Cocos, but no description nor reference is given. Whether the examples described below really fall under that head is doubtful.

The inflorescence of the coconut is contained in a clavate spathe which is at first completely closed and bears no resemblance to a leaf. The spathe splits open, usually down the outer face, but sometimes down one side, and the flowering branches fall out. At first most of them bend towards the lower side of the main axis, but they subsequently become more rigid and assume a symmetrical position with regard to the latter, falling again to the lower side as the fruits develop, and their weight drags the branches down. The asymmetrical appearance of the inflorescence as usually depicted is due, therefore, in the one case to the immaturity of its branches, and in the other to the weight of the fruit, not to an asymmetrical arrangement of the branches on the main axis of the inflorescence. In general, the branches of the inflorescence are simple. Within the spathe there may be one or two small triangular bracts on the lower part of the main axis of the inflorescence, while below each flowering branch is a very small ridge-like bract, usually not exceeding one-eighth of an inch in height.

In 1908 an abnormal inflorescence was forwarded to me from Minuwangoda from a tree forty years old, which had, according to its owner, never borne any other kind. The

spathe terminated in a solid stalk-like tip about 5 inches long, which bore a leaf 9 inches long. This leaf was fan-shaped and undivided, like the first leaves of a seedling coconut plant.

Within the spathe the main axis of the inflorescence bore a large number of long bracts and small flowering branches symmetrically arranged, the whole resembling a bouquet. Owing to the longitudinal compression produced by the closed spathe during their expansion, nearly all the bracts were strongly tranversely wrinkled at the base, and most of the flowering branches, and in some cases the bracts also, were repeatedly bent from side to side in permanent zigzags.

The first bract, counting from the base, almost sheathed the main axis completely ; its shape was elongated, triangular , 5 inches broad at the base, and 23 inches long.

The second bract was the same general shape, but only 2 inches broad at the base. Its length was 22 inches. In its axil was an aborted shoot, 4 inches long, tapering to a sharp point ; it was winged on either side, the wings being folded over and meeting down the centre of the adaxial face, so that it had rather the appearance of a leaf stalk. Further examples show that this is to be regarded as an aborted spathe.

The third bract was 3 inches across the base and 21 inches long. In its axil was the first flowering branch of the inflorescence. This was only 11 inches high, and was again abnormal. Instead of being simple, it bore eighteen (tertiary) flowering branches. The lower half of the shoot bore five successive triangular bracts diminishing in length upwards from 2 inches to half an inch ; these were followed by the eighteen flowering shoots, each with its own bract. The bracts of the lowest flowering shoots were longer than the empty bracts below and reached a length of 3 inches, but those situated higher up the axis diminished until the uppermost did not exceed a quarter of an inch. Thus, the secondary axes of the inflorescence repeat the abnormal features of the whole inflorescence.

The fourth bract was 22 inches long, and was split down to the base. It was apparently a fusion of two bracts, as there were in its axil an aborted spathe almost identical with that in the axil of the second bract, and a branched, bracteate, flowering shoot, similar to that in the axil of the third bract, but smaller.

Bracts Nos. five to twenty-six were similar to No. three, but were progressively shorter, with smaller and less branched flowering branches in their axils. Bracts Nos. twenty-seven to thirty-two had no flowering shoot in their axils, but aborted spathes, similar to that of bract No. two, but only about half an inch long.

Flowering branches re-appeared with bract No. thirty-three. In that instance the branch bore three tertiary branches, but the flowering branches which accompanied bracts thirty-four to thirty-six were simple. Bract thirty-seven bore a flowering shoot with two branches in its axil, but that of bract thirty-eight was again simple. In the latter case the bract was 5 inches long and the flowering shoot 4 inches. Subsequent bracts did not exceed in length the flowering branches they subtended. The remaining flowering branches, which were all simple, numbered sixteen, and their bracts diminished progressively upwards, until those of the last eight did not exceed one-eighth of an inch in length, *i.e.*, were normal.

As the length of the main axis from the point of insertion of the first bract to the tip was only 15 inches, it will be seen that the degree of condensation was extreme. All the bracts and secondary inflorescences were wedged together, and formed a moderately conical head, from which the long tips of the bracts of the main axis projected.

The bracts are thin, but rigid ; in texture they resemble the sheath at the base of the leafstalk in *Euterpe*, *Oreodoxa*, &c. In the case of the coconut leaf, this tissue forms the interwoven fibrous sheath known as the strainer.

All the flowers on this inflorescence were male, and as it is stated that the tree has never borne any fruit, it is probable that no female flowers are produced.

Abnormal inflorescences, in some respects similar to the foregoing, were obtained from Chilaw in 1914. The tree in this case is about seventeen years old, and, as in the previous instance, it is said that it has never borne other than these abnormal inflorescences.

One of the examples forwarded was still unexpanded. Apparently the spathe had been removed ; at least there was

no true spathe on the specimen. The whole structure resembled an elongated cylindrical bud, and was about 50 inches in length, with a maximum diameter (at the base) of only an inch and a half. The main axis of the inflorescence bore sixteen " leaves " enclosed within one another. Each of these consisted of a bract-like structure, from 30 to 40 inches long, usually furnished with a leafy tip. Their bases were somewhat inflated and resembled in texture the bracts of the previous inflorescence, but higher up they became thicker and more nearly resembled the tissue of a spathe. They thinned out on either side into incurved wings, which overlapped on the opposite side of the bud for the greater part of its length. Towards the apex, however, the wings ceased to meet, and that part of it was merely channeled. The longest leafy tip was 20 inches in length, but only one inch in breadth; it was simple, not pinnate. The majority of the bracts bore similar tips, but in few cases they were wanting. The main axis of the inflorescence terminated in a small simple leaf about a foot in length.

There was no sign of any flowering branch in the axils of these reduced leaves. The phenomenon might, perhaps, be classed as a case of chloranthy were it not for the evidence of other inflorescences from the same tree.

Examination of a second, older, expanded specimen gave the following details. The main axis of the inflorescence bore thin bract-like structures, twenty in all, similar to those of the Minuwangoda tree. These were inflated at the base and strongly transversely wrinkled, and measured up to 4 inches in breadth at the base and 8 inches in length. But each bract terminated in a fairly well-developed pinnate leafy tip up to 5 inches in length. The main axis bore at the apex four small normally pinnate leaves up to 24 inches in length, and furnished with sheaths at the base of the leaf stalk. In this example each bract bore an aborted spathe in its axil; these were up to 6 inches in length, and differed from the structures found in the corresponding position in the inflorescence of the Minuwangoda tree in being completely closed and therefore hollow. There can be no doubt that these represent aborted spathes.

The main axis of this inflorescence also was remarkably short, measuring only 5 inches from the point of insertion of the first bract to the base of the terminal leaf stalk.

It would appear that in these examples the bracts are an excessive development of normal bracts, and that their production is attended by the entire or partial suppression of the flowering branches. In the Minuwangoda example the female flowers are wanting, and in one region of the inflorescence the flowering branches are represented by aborted spathes. In the Chilaw examples the flowering branches are replaced by aborted spathes in one case, while in the other they are completely wanting.

Hypertrophy of the Perianth.

A possible example of the abnormality figured by Masters on page 428 of his book was obtained at Matara in 1914. Unfortunately the specimen had been collected a long time previously, and nothing could be ascertained regarding its history.

Of the six segments of the perianth which are normally found beneath the coconut, four are present. These are quite normal. The perianth had been detached, and it is impossible to state whether two segments have been lost, or whether these are to be regarded as represented in or by the abnormal structures above.

The place of the ordinary drupaceous fruit is occupied by two opposed structures. On the one side is a broad curved piece with some approach to the appearance of a flexed hand. It is evidently composed of five segments fused together laterally ; these are indicated by strong ridges and furrows on the convex outer surface, and by five triangular teeth into which it divides at its upper edge. The five segments arise side by side from the base and are practically all of the same size. Measuring round the curve this piece is 7 inches high and 6 inches broad ; its maximum thickness was one inch. The lobes at the upper margin are half an inch long, and owing to the curve are directed almost horizontally.

Opposed to this is an erect, more or less oval structure, 6 inches high and 2 inches in diameter. It is strongly longitudinally fluted, but it is not possible to correlate these ridges with the original structure of the flower. It arises

partly from the edge of the main axis (like the other piece already described), and partly in continuation of the main axis.

This oval structure contains in the centre a small cavity which is triangular below, and about eight millimetres broad there, but becomes V-shaped above owing to the ingrowth of one side. The length of its side at the broadest is twelve millimetres. The other piece is solid, except for fortuitous cracks caused by drying. The whole of the tissue in both pieces is that of the husk; there is no indication of nut or shell.

Masters regarded the presence of similar structures as due to "an hypertrophied condition of the segments of the perianth, which have not only increased in length as the central nut has ripened, but have developed in their tissues that fibrous tissue which ordinarily is found in the pericarp only. This view of the structure of these nuts is borne out by the fact that under normal circumstances the base of the perianth contains a considerable amount of fibrous material. In the present case this has increased to such an extent that the fruit appears surrounded by a double husk, by an inner one as usual and by an outer six-parted one." The illustration shows a fruit, apparently normally formed, with two of the additional claw-like segments. It is not stated whether a normal nut was found in the main fruit.

One would scarcely say that under normal conditions the base of the perianth contains any considerable amount of fibrous material. Moreover, there is apparently no evidence whether the normal perianth was or was not present when the nut was growing. Unless the specimen were carefully gathered with part of the branch, and equally carefully preserved, the perianth would soon drop off. Its absence, therefore, from a dried specimen cannot be taken to indicate anything.*

But whether Masters' explanation is correct or not, it is clear that it does not apply to the recent Ceylon specimen, in which the fruit is replaced by a six-partite husk in two sections. It would seem probable that this latter example owes its origin to some abnormal division of the ovary.

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* While the above was in the Press I have received two more examples of this abnormality, in each of which the normal six-partite perianth is present.

The Effect of Lightning on Coconut Palms.

BY

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IN a recent publication, entitled "Die Blitzgefährdung der verschiedenen Baumarten," Dr. Ernst Stahl has collected and discussed all that is known of the effect of lightning on trees, and has described new experiments, which afford further explanation of the natural phenomena recorded. It is remarkable that practically the whole of the information available refers to temperate climates; indeed, that which relates to the tropics is so brief that it may be quoted in full:—

According to Hann (Handbuch der Klimatologie, Bd. II., page 20), the lightning which accompanies the violent thunderstorms of the tropics has the most remarkable peculiarity that it very seldom sets things on fire or proves fatal. Moreover, injury to trees is relatively much less frequent than in temperate climates. During a stay of four months at Buitenzorg, which happened to coincide with the rainy season, when severe thunderstorms occurred almost every day, I only remember hearing of two cases, the one a palm, and the other a large *Ficus elastica*.

Seeman (Journal of Botany, V., page 378) has noted that "no observations seem to be on record of coconut palms being injured by lightning, though, as Tennent in his well-known work on 'Ceylon' states, they are known to be excellent lightning conductors."

A short communication from Herr Z. Kamerling records that injury by lightning occurs from time to time in Java and Sumatra, for example, in the case of the coconut palms, but somewhat rarely. He is of opinion that the numerous trees bring about a slow equalization between the earth and the clouds, and that discharges, in general, take place from one cloud to another, but only rarely between the clouds and the earth.

Dr. C. Bernard states that at Buitenzorg *Albizzia* and *Ficus* are often struck by lightning, and coconut palms are killed. But he notes that *Oreodoxa* and other palms, which often stand in isolated positions, are not struck, and suggests that the vertical shoot formed by the young unfolded leaves acts as a lightning conductor. None of the palms which form the *Oreodoxa* and *Areca* avenues in the Botanic Gardens have up to the present been struck by lightning.

Pechuel-Loesche (Uber Blitze und Blitzschlage, page 93) has recorded that in spite of careful search he was not able to find trees injured by lightning in the regions of the Loango Coast, though at various times he had observed the lightning fall on isolated giant trees so near at hand that he heard only a short, sharp, clap of thunder.

The natives display no fear of lightning ; they take shelter under trees without hesitation if they are caught in the open by thunderstorms. The view that very few flashes reach the ground might, therefore, appear to be justified. But I cannot agree with that opinion ; and I would venture the explanation that the enormous volume of rain water which saturates the porous soil, or, while running off, constitutes a mantle over the thick thatch of the huts probably, being a good conductor, affords protection to the latter at least. Pechuel-Loesche's observations can no doubt be explained by the fact that the tropical rainstorms soon wet the bark, which is generally smooth, and so furnish a practical protection.

In dealing with the Mediterranean region, Dr. Stahl cites Dr. Trabut as stating that in Algeria thunderstorms and injury by lightning are rare, but in the oases the date palm is frequently struck. In the case of one palm which had been struck a short time previously, Dr. Trabut found the crown dead and in course of decay, and a long split in the stem. The author accounts for this excessive injury to the date palm by the facts that it is taller than the surrounding vegetation, that in consequence of the structure of its crown and stem it is not readily wetted by the rain, and, not least, by its position in a damp situation in a dry region.

It will be noted, no doubt with some astonishment by residents in the tropics, that the records which Dr. Stahl has been able to discover of injury by lightning to tropical trees in general and palms in particular are remarkably few. This is no doubt to be explained in great measure by the fact that the daily commonplaces of tropical life pass unrecorded, though it would appear to be correct that, comparatively speaking, the frequent thunderstorms of the tropics cause less injury than those of temperate climates.

This latter view is fairly widely held. Von Danckelmann, writing in " Nature," December 11, 1884 (Vol. 31, page 127), stated :—

It is a remarkable fact that in all the publications relating to Africa we so seldom come across accounts of injuries caused by

lightning. Some travellers—those of the German Loango Expedition of 1873–76 for example—even distinctly report that, notwithstanding the extreme frequency of lightning in Africa, cases of damage inflicted by it are almost unheard of. During my own stay on the Congo, though I was eagerly on the lookout for instances of this kind, I did not succeed in authenticating a single case of injury due to the electric fluid. There was, indeed, a vague rumour among the natives of a man in some village having been struck dead and a "tshimbek" burnt down by lightning, but I could find no eyewitnesses of the fact; and all the time I was in Africa I never saw a tree or other object which showed signs of having been struck by lightning. The only case of which I obtained any authentic report was that the coal magazine of the French factory at Banana was burnt down in consequence of a lightning stroke in March, 1882. I have been recently informed, however, that just a year after the destruction of the French coal magazine, the large gin store of the Dutch factory at Banana was similarly destroyed, a flash of lightning having kindled a great fire there, which lasted four days. As a result of these two accidents following so close on one another in the same locality, lightning conductors are now being set up at Banana, and the International Association of the Congo has had conductors fixed on all the magazines at Vivi. I find in Dr. Pogge's journals, which I am now preparing for publication, an instance, witnessed by that traveller himself, of a man being killed by lightning. As far as my own researches go I find scarcely any literature concerning the use of lightning rods, or the frequency of accidents from lightning in the tropics," &c.

The foregoing communication elicited a letter from J. J. Meyrick ("Nature," Vol. 31, page 194), who wrote as follows:—

My experience confirms the remarks of Dr. Von Danckelmann in "Nature" (page 127) respecting the little damage done by lightning in tropical countries. In the plains of India, at the commencement of the monsoon, storms occur, in which the lightning runs like snakes all over the sky at the rate of three or four flashes in a second, and thunder roars without a break for frequently one or two hours at a time. During twelve years' residence in India I heard of only two human beings, and, I think, three buildings, being struck, although in parts of Lower Bengal the population amounts to more than 600 to the square mile. I always attributed the scarcity of accidents to the great depth of the stratum of heated air next the ground keeping the clouds at such a height that most of the flashes pass from cloud to cloud and very few reach the earth. This idea is supported by the fact that in the Himalayas, at 6,000 feet or more above the sea, buildings and trees are frequently struck. I have seen more than a dozen pine trees which had been injured by the lightning on the top of one mountain between 8,000 and 9,000 feet high. In the British Islands thunderstorms are said to be more dangerous in winter than in summer, and such a fact if true can be explained

by the very thin stratum of air then intervening between the clouds and earth.

On the other hand, Dr. A. Ernst wrote from Venezuela, where he had resided for twenty-two years :—

Thunderstorms are very frequent during the rainy season. They break out generally in the afternoon, about the time of the daily maximum of heat, whilst they are extremely rare in the morning (I only witnessed one case) and during the night. Statistics of accidents do not exist, nor are there many lightning rods in use (in Caracas about half a dozen). But there are certain regions where the former are far from being uncommon, as, for instance, the country round the Lake of Valencia and the plains or *llanos* to the north of the Orinoco. In these a considerable number of cattle are killed by lightning every year, and I know also of several cases where houses were destroyed and people killed. The herds of cattle crowd together as soon as a thunderstorm begins, and the animals remain during the whole time with their heads down to the ground, thus avoiding instinctively that their pointed horns should act as lightning conductors (*sic*). In the neighbourhood of Maracay, at the eastern end of the Lake of Valencia, accidents occur almost every year ..... Near Caracas accidents are comparatively rare. During all the years of my residence here no more than six have come to my knowledge ; in three of them some damage was done to buildings, in two cases large trees were split, and in one (October, 1882) a ploughman was killed while at work in the field, together with his two oxen, his driving stick (about four yards long and shod with an iron point) having acted as a lightning conductor.

To the above may be added the following extract from a recent number of the same Journal ("Nature," Vol. 94, page 261) :—

In Symons's Meteorological Magazine for July last (1914), Mr. L. C. W. Bonacina asked readers who had been in India whether lightning casualties, notwithstanding the severity of tropical storms, are not much rarer there than with us. He pointed out that many persons agree that thunderstorms in England are much more dangerous than in India. In the issue for October a correspondent (G. G.) states that in the course of his travels in various parts of India during a period of several years he had only known, or heard of, one case of death by lightning, though a few high buildings, notably near Delhi, and tall trees in mountain districts had been struck. He, therefore, answers Mr. Bonacina's question in the affirmative, the reason being given that thunderstorms occur higher up in the air. He states that he has never seen lightning in India so near the earth as in England.

It will be seen that the information elicited in 1914 is practically the same as that of thirty years earlier, and is

based on general opinions, not on detailed and continuous observation. It would appear, therefore, that there is still need of careful records of the effects of lightning in the tropics.

The records of the Registrar-General of Ceylon give the average number of deaths by lightning in this country as ten per annum from 1891 to 1898, and eleven per annum from 1898 to 1910. The actual numbers for each year from 1899 are given in the following table :—

1899 ..	.. 16	1906 ..	.. 7
1900 ..	.. 18	1907 ..	.. 15
1901 ..	.. 17	1908 ..	.. 15
1902 ..	.. 13	1909 ..	.. 11
1903 ..	.. 2	1910 ..	.. 10
1904 ..	.. 9	1911 ..	.. 2
1905 ..	.. 4		

The population of Ceylon in the year 1911 was 4,106,350.

That coconut palms are killed by lightning is well known to all coconut planters. The editor of the " Tropical Agriculturist " wrote in 1886 (Vol. VI., page 73) : " Those connected with coconut estates are aware that, besides the destruction of young trees by the grubs or beetles, they must lay to their account a varying but appreciable percentage of loss of trees at all stages of growth from the effects of lightning ; " and the well-known Ceylon coconut planter, Mr. W. H. Wright, stated in " All about Coconut Planting " (3rd edition, 1914, Appendix, page iv) : " The ills a coconut property is heir to are drought, white ants, beetles, and lightning." The statement of Sir Emerson Tennent, referred to by Seeman (*loc. cit.*), is : " One pre-eminent use of the coconut palm is omitted in all these popular enumerations, it acts as a conductor in protecting their houses from lightning. As many as 500 of these trees were struck in a single pattu near Puttalam during a succession of thunderstorms in 1859."

But though the destruction of coconut palms by lightning is an undoubted fact, it is necessary to exercise considerable caution in accepting that as an explanation of the death of trees in any particular case. As a general rule, the native always assigns the death of a coconut palm to lightning, or, in the rare event of the absence of thunderstorms for any

considerable period, to a " falling star " or a " meteorite." Until quite recently deaths from budrot were always so explained, and probably cases of root disease also, while I have been offered the same theory in the case of a tree which was obviously killed by " red beetle " (*Rhynchophorus signaticollis* Chevr.). When the observer is not the owner of the trees in question, but merely after the storm examines the locality to find out " what the lightning struck," the possibility of error is still greater, for he is apparently content to accept headless stems as evidence of the lightning stroke, without pausing to consider what has become of the crowns, and in many cases he relies on the evidence of trees, which the pathologist could inform him had been headless for months previously.

The damage inflicted on coconut palms by lightning may take any one, or any combination, of the following three forms :—

(1) The crown may be set on fire.
(2) The tree may be mechanically injured, either by splitting of the stem or by defoliation.
(3) The tree may exude a liquid which dries in red-brown streaks and patches on the stem.

Combustion of the Crown.

This has been recorded by Frank (Krankheiten der Pflanzen, 2nd ed., I., page 241), who states that the dry branches and leaf stalks of palms are sometimes set on fire by lightning.

In 1895 considerable interest was aroused in the Ceylon daily press by the report that a coconut palm had been seen with its crown on fire at Pondicherry. The subsequent correspondence has been recorded in the " Tropical Agriculturist " (Vol. XV.), and from the opinions expressed it would appear that lightning was generally considered a normal explanation. One correspondent recalled that a similar occurrence had been observed in 1893 or 1894 near Christ Church, Colombo, during a severe storm (" Tropical Agriculturist," Vol. XV., page 351), while Mr. W. H. Wright stated that some time ago he had witnessed a coconut tree taking fire from a flash of lightning just before the rain came down.

but he had never seen any tree on fire during the rain, a fact which he thought might be explained by supposing that the tree could not take fire when wet. On the other hand, another well-known coconut planter, Mr. Jardine, wrote that he had never seen a coconut tree set on fire by lightning or a meteorite, though he had seen hundreds struck by lightning ("Tropical Agriculturist," Vol. XV., page 345).

In 1907 it was reported in the local press that a coconut palm in Colombo had been set on fire by lightning during a storm.

This effect would appear to occur in the case of coconut palms in town gardens, where many old trees, hemmed in by buildings, are barely able to exist, and so may bear more dead and dry fronds than their more fortunate relatives on cultivated estates. But it is certainly not the most usual effect of lightning. That it should occur before the rain and not during the storm is only to be expected, as the coconut stem is rapidly wetted by the stream of rain water which descends from the crown, and under such conditions it forms an efficient conductor.

Mechanical Injury.

H. H. Thiele, writing in the Fiji Planters' Journal" (see "Tropical Agriculturist," December, 1913, page 462), states: "Lightning will, as a rule, shatter one or two trees badly, and those standing close by will be damaged by the heat to such an extent that they get diseased, their tops rot, and they die, their stems being marked with a number of brown spots." How far this is based on actual observation is not apparent.

In the "Tropical Agriculturist," Vol. VI., page 73, the editor wrote: "During the last monsoon storms twelve fine palms, a little to the south of the Kollupitiya station, were struck. Five of these were practically decapitated and others were badly burnt, but some were only affected so that a slight brown colour showed on a few of the branches."

Shattering of the stem or immediate decapitation of the coconut palm would appear to be rare. I have never seen any case of decapitation as a direct and *immediate* consequence of lightning. Of course, when a palm dies after having been

struck by lightning, its crown ultimately decays, and only the headless stem remains after a few months. In the only case of mechanical injury which I have observed, the stem bore two short vertical wounds, one at 12 feet and the other at 18 feet from the ground, from each of which the fibres were protruding in loose bundles.

Exudation of Liquid.

This is by far the commonest effect of lightning on coconut palms. As a rule, no sign of injury to the stem, or scorching of the crown, is observable, but the stem exudes, at numerous points, a liquid which dries in red-brown streaks and patches on its surface. The earliest stage of this which I have seen was two or three days after the tree had been struck. The plantation was fourteen years old and the palms were 22 feet apart ; all were about the same height, but only one was affected. It did not appear to differ in any respect from the surrounding trees, and there was no apparent reason why it should have been struck rather than any other. Its stem was about 10 feet high, and the central spike about 10 feet more ; in consequence of its small stature, the tips of the decumbent outer leaves nearly touched the ground.

The stem was not split or marked by the lightning in any way. Owing to the collapse of the inner tissues of the bud, the central spike had fallen over, but it was still green and not charred. The outer leaves, *i.e.*, those which bent over towards the ground, were charred along the midrib ; and round the tree, at distances of 8 or 10 feet from the trunk, the grass and weeds were burnt in small patches, each patch being situated below the point of a leaf. But the most striking phenomenon was the exudation of sap from the stem. Liquid was oozing out from the innumerable cracks which are always to be found in the " rind " of the coconut stem, forming white frothy masses and then running down in long red streaks. The appearance gave one the impression that the whole of the internal tissues were undergoing rapid fermentation. On cutting into the stem the internal tissues were found to be slightly pale brown, uniformly coloured, and full of sap. It is to be regretted that, as the tree was situated

in a district at least three days' journey from a laboratory, no further investigation could be made.

Another case was examined about a month after the occurrence. A breadfruit tree (*Artocarpus incisa*) was said to have been actually struck, and this was dead and leafless, though its trunk was not split. Close to it was a coconut palm about 12 feet shorter. This was not quite dead; it showed long red streaks of sap, particularly in the lower half of the stem, and had two short vertical wounds, one at 12 feet and the other at 18 feet from the ground, from which the vascular bundles were protruding in loose masses. Westward from these two the palms, only 15 feet away, showed no sign of injury, but to the east twenty trees, which were taller than the breadfruit tree, were affected. Their trunks bore red bleeding spots, and their crowns were scorched, the outer leaves being generally withered and drooping, though the youngest leaves were still erect and green. None of these showed any injury to the stem, except the exudation of sap. Two palms had been felled, as being beyond recovery, and four others appeared to be dying. The tree with the worst crown was about 20 yards from the breadfruit tree, and the affected area formed, roughly, an ellipse, with the breadfruit tree at one focus.

In general, the effects of lightning on coconut palms may be summarized as follows. A group of trees, not differing in any obvious respect from the surrounding trees, is affected; sap exudes from the trunks of all these trees; their crowns are slightly scorched; one tree is more severely affected than the others, and this is regarded as the tree actually struck. In some cases longitudinal wounds are made in the stem; and if the crown is surrounded by dead leaves these may be set on fire. But apparently these last two effects are rare. The occurrence of injured trees in groups is especially remarkable.

As regards the ultimate fate of coconut palms struck by lightning, there would appear to be a considerable difference of opinion. To quote again from the "Tropical Agriculturist" (Vol. VI., page 73): "On one occasion, when a crash gave rise to the impression that 'the sky had fallen,' we felt certain that something had been struck, and on going to the seashore

we found seven coconut trees affected, some killed outright, and others with only the edges of their branches (*i.e.*, leaves) singed. But ultimately every tree, however faintly affected, died. During the late monsoon storms twelve fine palms, a little to the south of the Kollupitiya station, were struck. Five of these were practically decapitated, and others were badly burnt. But some were only affected so that a slight brown colour showed on a few of the branches. Amongst the latter is a tree with a magnificent head of fruit, and this morning we expressed our fears, based on our experience, to a good native authority, that this valuable tree was as much doomed as those whose vitality had been at once destroyed. He fully confirmed our opinion: the tree must die." It would have been of greater value if the fate of this tree had been recorded. With regard to the first of these occurrences, the statement that several trees were immediately "killed outright" makes the record somewhat doubtful.

The general opinion, however, inclines to the belief that coconut palms which have been struck by lightning may recover if properly treated. The treatment adopted by the native is apparently based on the observation that a liquid exudes from the stem; he merely cuts a hole in the stem "to let out the excess of sap." W. H. Wright, in "All about Coconut Planting" (3rd edition, Appendix, page iv), stated: "When a tree has been partially struck by lightning, steps should at once be taken to bleed it and the surrounding trees by boring holes at their bases with an auger, by which means a large percentage can be saved. Any tree, however, which has been irretrievably struck by lightning should at once be cut down and burnt."

The distinction between "partially struck" and "irretrievably struck" would appear to afford a convenient explanation in case the treatment failed. It does, however, appear to be correct that when a group of coconut palms is struck, some are more lightly affected than others. The former are not regarded as actually struck, but as "affected by the heat." Their case may be analogous to that of the tea bushes which die round a rock which has been struck by lightning on a tea estate. It would appear to be open to

question whether the trees which recover after the treatment described would not have recovered without treatment of any kind.

No explanation of this "fermentation effect" can at present be offered, and the facts have been placed on record here in the hope that the subject will be taken up by others more favourably situated for detailed investigation. It may, however, be pointed out that the same effect may be produced on a small scale by making a fire near the base of a coconut palm, but not near enough to char the stem. The red-brown patches subsequently appear on the parts which have been heated. A number of red-brown spots and streaks at the base of the tree, usually on one side only, indicates that it has been injured by fire. This appearance is very common, more so in native gardens or on trees near a native hut than on estates. If a fire is made quite close to the base of a coconut palm, the outer stem tissues are, of course, burnt and charred ; but when it is too far away to admit of this, the stem is heated, especially if the wind blows the flames in that direction, and it afterwards exudes a red-brown liquid from dozens of the pre-existing cracks. It is notable that in some cases, not, however, universally, when the lower part of the stem is severely charred, the parts immediately above this do not bleed ; on the other hand, if the stem shows no blackening whatever, it bleeds vigorously. Probably in the first case the supply of sap to the upper parts of the cortex is cut off altogether.

I have seen an area of several acres affected in this way, where the grass had evidently been burnt off a long time before. All the trees were marked with red-brown spots to a height of about 3 feet on one side only. Apparently a quickly advancing fire had not been strong enough to char the stems, or to heat them sufficiently on the leeward side to cause them to bleed.

A good example of this was furnished by a group of old coconut palms over sixty years old on the Experiment Station, Gangaruwa. The plot being more or less waste ground, it was used for storing the thinnings of the cacao plots in 1907, and these were set on fire in February, 1908, without any regard for the coconut palms. When examined in April, 1908, the

lower parts of the stems, sometimes to a height of 25 feet, were covered with small red-brown patches. The liquid had issued from the cracks and had dried round them ; it had not run down the stem, as in the case of a severe lightning stroke. The cortex under each patch was slightly decayed and brown, but it afterwards dried up. Four trees were marked above the highest red-brown patch. On three of these the bleeding had not extended further up the stem by March, 1909, but on the fourth there were fresh spots higher up the stem at the end of July, 1908. As a rule, on trees which have been injured by fire the bleeding occurs immediately afterwards, and the spots do not subsequently increase in number or size. Only the cortex is affected, and the amount of sap which exudes is small. But when trees are severely struck by lightning, the exuding sap is derived from the whole of the inner tissues, and issues in such quantity that it runs down the stem in long streaks.

Horse-hair Blights.

BY

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AMONG the many tropical mycelia which are abnormal, either in habit or structure, none is more striking than those which have received the general appellation of "Horse-hair Blight," a designation which has been bestowed by planters in Ceylon, India, and the West Indies on thin rhizomorphic mycelium, which spreads freely over bushes and trees at some height above the ground. As far as these mycelia have been identified, they belong in all cases to some species of *Marasmius*, the common species in the Eastern tropics being *Marasmius equicrinis*, and that in the West Indies (according to the records) *Marasmius sarmentosus*. The following details relate chiefly to those species which have been found in Ceylon.

Marasmius equicrinis Muell.

The mycelium of this species is the common horse-hair blight of Ceylon. It consists of a smooth, tough, black cord, from one-tenth to one-eighth of a millimetre in diameter, which runs in all directions over bushes and trees, up to a height of 20 feet above the ground, attached to the living stems and leaves at intervals of one to four centimetres, or throwing out long free threads to adjacent branches. Its course is quite a random one. After proceeding along a branch for a short distance, it may leave it and attach itself to a leaf, and after crossing several leaves may return to its original branch. Or it may travel from a branch to a leaf *viâ* the leaf stalk, and may make a complete circuit of one surface of the leaf before proceeding further. In general, the whole of the mycelium is aerial; it is not connected with any mycelium on the ground, and does not ascend the tree from the ground level. It has been observed at the base of

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Hevea trees, where it grows on the outer dead bark, but this is an exceptional case, and it has not been known to climb up to the leaves from that position.

When the leaves die they adhere to the mycelium until they decay and disintegrate, and consequently there is produced a tangled mass of leaves and mycelium, with sometimes twigs also, suspended in the bush or tree. The mycelium, however, does not appear to be parasitic.

In India what is apparently this species is said to be common in the jungle, especially on *Terminalia tomentosa* Bedd., and to spread thence to tea bushes. It is quite common in low-country jungles in Ceylon, where, with the white "thread blight," it grows on the bushy undergrowth. It has not been found on cacao in Ceylon, as *M. sarmentosus* has in the West Indies, and this is somewhat surprising, since the conditions in a cacao plantation are such as favour its growth; but, on the other hand, cacao in Ceylon is grown chiefly at medium elevations, not in the moist low-country, where horse-hair blight flourishes most luxuriantly. In the Royal Botanic Gardens, Peradeniya, it occurs with "thread blight" on nutmeg trees (*Myristica fragrans* Houtt.), but it does not spread far. In the damp low-country jungles it spreads freely from bush to bush, *e.g.*, in the jungle at Henaratgoda (elevation 33 feet, rainfall 107 inches per annum).

Cultivated tea forms a low bush about 75 centimetres high, and the bushes are planted so close together that their branches meet; but though the ground is sometimes hidden, the vegetation is not high enough to retain a permanently moist atmosphere. Probably for that reason the mycelium on tea is usually confined to the main branches in the centre of the bush. This is the case in the Kelani Valley district, in which it is most prevalent, though in the jungle surrounding the tea it runs freely over the bushes, as at Henaratgoda. Further inland, at an elevation of 400 to 500 feet, and with a rainfall of 80 to 90 inches per annum, it has been found to spread similarly over the tops of tea bushes; but in this case the tea was shaded by interplanted *Hevea*, and the conditions more nearly approach those of the jungle than did those in the other tea fields in which it has been observed. I have no

record of its occurrence at higher elevations than Peradeniya (1,600 feet, rainfall 82 inches), though another species with slightly different mycelium occurs in the jungle at Hakgala (5,600 feet). In accordance with the idea that Peradeniya is its upper limit, we find that it does not spread there to any extent. The Nutmeg Grove in which it grows consists of closely planted old trees, whose branches interlace and create a dense shade. There horse-hair blight is practically confined to the lower branches of two trees, both of which are overhung by tall specimens of *Derris dalbergioides*. It would appear that the fungus prefers the moist low-country, and that it flourishes best on bushes which are shaded by trees.

The black mycelial cords are cylindrical, smooth, and shining. Towards the growing point the colour becomes paler, and the last millimetre is brownish-white. The cross section is circular or slightly oval, and as the component hyphæ run parallel and adhere to each other throughout the whole length of the cord, the section presents a ring of polygonal "cells," which are 2 to 4 μ in diameter. In the older regions the external hyphæ are blackish-brown, and the colour becomes paler inwardly through brown and yellow-brown until the internal hyphæ are hyaline. The full-grown cord is hollow, the cavity occupying half the thickness of the cord; near the growing point the cord is solid, and the colour varies internally from pale brown to hyaline, while the diameter is only about 60 μ.

The growing point is protected by a cap, easily discernible without a lens, which bears a striking resemblance to a root cap. This cap is 220 to 280 μ long and about 120 μ broad, and is rather darker than the cord immediately behind it. The tip is conical, the breadth increasing uniformly to the middle, after which the remainder is cylindric, or diminishes almost to the diameter of the immature cord. The conical tip is solid and its outer edge is amorphous, *i.e.*, it shows no trace of constituent hyphæ when mounted; but the hinder half of the cap forms a free curtain round the stem, and in it the constituent hyphæ are distinguishable in mounted specimens. The free edge of this fringe or curtain is irregularly laciniate. As a rule, the fringe is continuous with the outer

layer of the solid tip, but in some cases it arises from a deeper layer, and the cap then appears double.

At first sight this cap appears to be a developing pileus. But when the mycelium produces pilei, these do not arise from the tip, but always on short stalks developed as side branches from the older parts. Further, the developing pilei differ from the cap in not having a laciniate fringe at their margin. That the cord grows on without any change in the character of the tip has now been observed in numerous instances when the mycelium has been kept growing in the laboratory. Hence it would appear that the cap is a special structure, though most probably a modified pileus, for the protection of the growing point.

The mycelium adheres to the leaves and branches by means of thin discs of fine brown hyphæ which spring from the under surface and sides of the cord. These discs may be circular, about 0·6 mm. in diameter, or oval, up to 3 × 0·75 mm. The individual hyphæ are glued together into a sheet which thins out towards its margin, and the same fixing substance (? from a degeneration of the outer wall of the hypha) fastens the disc to the leaf or branch. On old rough branches these discs give rise to a few free hyphæ which wander between the fragments of dead bark ; on young green stems and leaves there are no free hyphæ, and in neither case have I been able to detect any mycelium in the living tissues of the host plant. When any part of a stem or leaf with its adhering mycelium is placed in alcohol, the fixing substance is apparently dissolved, since the whole mycelium separates from the host at the slightest touch. This tends to confirm the view that the mycelium is entirely superficial. But the individual hyphæ of the attaching disc do not separate from each other in alcohol.

These anchoring hyphæ may arise anywhere along the whole length of the cord, and their production seems to depend on external conditions. If a piece of mycelium is placed in a glass dish and kept so moist that it is always in a thin film of water, a fringe of brown spreading hyphæ, to a length of over a centimetre, develops from each side of it. It would seem, therefore, that an abundant supply of moisture at certain

points would result in the formation of discs at those points, but I have not been successful in attempts to prove that by experiment. There is no relation between the position of the discs and the stomata of the leaf ; indeed, the cord adheres to either side of a leaf, even in cases, *e.g.*, nutmeg and tea, where there are no stomata on the upper surface. It appears to prefer leaves which have a glabrous surface.

A careful examination of the trees tends to confirm the supposition that the mycelium is not parasitic. In the case of nutmeg, leaves bearing the cords of horse-hair blight do not die out of their natural order ; this is the more easily determined, since dead leaves remain attached to the mycelium. It is seldom that all the leaves of a shoot are attacked, and any gaps with hanging leaves could not be overlooked. It seems certain that the dead leaves in the tangle (when they belong to the tree on which the fungus occurs) have died normally, and that the mycelium merely prevents their fall to the ground. The twigs which sometimes occur in the tangle present more difficulty, but an examination of the branch usually shows that they are not part of that particular one. In the case of nutmeg, an examination of unaffected trees brings out the fact that twigs of the latter are often broken off (by the wind ?) from the upper branches, and remain entangled in the denser lower ones ; they would be far more likely to be caught when the lower branches are overgrown by horse-hair blight. But that leaves and twigs blown by the wind or falling from higher trees are caught in the tangle is fully demonstrated. The largest leaf, indeed the only one recognizable, in the photograph of horse-hair blight on tea is that of *Grevillea robusta*, which is grown as a wind-break in tea ; and the commonest " twig " in the tangle on nutmeg in the Peradeniya Gardens is the rachis of the inflorescence of the overhanging *Derris dalbergioides*. This rachis is only about 10 cm. long and is very slender, but it falls with the seed pods attached at an acute angle and thus hooks over the cords of the horse-hair blight. Leaves of the latter tree are also common in the tangle.

Thus, both the absence of mycelium from the internal tissues and the effect of the fungus on the tree bear out the

view that this horse-hair blight in Ceylon is merely epiphytic. The fungus may obtain its nourishment at first from the dead bark of the older branches, and later from the leaves and twigs of the tangle. But that all " horse-hair blight " is the same and will have the same effect is, however, by no means probable.

A parasitic white mycelium of normal texture, usually known as thread blight, grows on branches and leaves in the same position as horse-hair blight, though it follows closely the course of the branch, and only passes from one leaf or twig to another when these are in contact. This often occurs with horse-hair blight in the West Indies and Ceylon, and the association has given rise to the idea that the two are forms of one fungus. But in Ceylon they are quite as often found separate, and are, in fact, totally distinct fungi. Any damage done to the tree when the two are found together is due to the thread blight ; indeed, it is most probable that in these cases the horse-hair blight only begins to grow after the thread blight has killed some of the twigs. There is no doubt that they are distinct fungi ; the horse-hair mycelium produces a *Marasmius,* but the immature fructifications of the Ceylon thread blight are small white sessile pilei with hardly a trace of gills. The fructification of horse-hair blight may easily be obtained ; that of thread blight refuses to grow under similar conditions. The horse-hair blight of the West Indies has not been studied apart from thread blight, and no definite decision as to its possible parasitism has been arrived at.

The fructification of this horse-hair blight occurs fairly frequently on the mycelium on the tree, but is usually very poorly developed in that situation. It generally arises laterally from a free portion of the cord, not from a point of attachment to a leaf or branch. Many of them arise not directly from the horse-hair mycelium, but from the decayed twigs in the tangle. The stalks are 2 to 10 mm. long ; there is a slight thickening at the point of origin, but elsewhere they are about the same diameter as the cord. As a rule, the pilei do not exceed 2 mm. in diameter, but after continued rains they may attain 5 mm. They are yellow-brown to red-brown, somewhat membranous, hemispherical, umbilicate, deeply

sulcate ; the sulcæ correspond with the gills in number and position, and are usually five to seven. There is a small black point or umbo at the base of the umbilicus, and unexpanded specimens of about a millimetre in diameter are often sharply umbonate. The gills are white, then cream or yellowish, becoming brown in drying ; in large specimens they are comparatively broad, but narrowed behind, where they unite into a well-defined collar round the apex of the stem. In poorly developed specimens the gills are so far attenuated behind that this collar is not very evident, but it can always be demonstrated by cutting diametrical sections of the pileus. The spores are white in mass, narrow-oval and inequilateral, or clavate, 10–14 × 4 μ ; contents granular. The pellicle of the pileus when magnified appears minutely roughened, and sections show that it is composed of elongated cells, echinulate, or rather nodular, with numerous close set, blunt spines at the outer ends.

If the tangle be placed in a glass dish with sufficient water to moisten the lower twigs and leaves, the fructification may be developed, as a rule, within two or three weeks. In this case, owing to its development in a constantly saturated atmosphere, the stalks are longer, 2–4 cm., and the pileus may attain a diameter of 8 mm. The pileus is somewhat thinner, paler in colour, varying from ochraceous to almost white, and it frequently becomes repand. In the case of a tangle taken direct from the tree to the laboratory the pilei developed in sixteen days, but on living tea branches, which were sent through the post, taking three days in transit, they did not develop until seventy-one days had elapsed.

The fructification of this horse-hair blight is clearly a *Marasmius*, and, from a comparison with the specimens in the Kew Herbarium, it is *Marasmius equicrinis* Müll. The question of nomenclature will be dealt with subsequently.

On searching during the wet season among the dead leaves and twigs beneath the nutmeg trees on which *Marasmius equicrinis* flourishes, one finds specimens exactly similar to those which develop on the tangle when it is placed in a glass dish and kept moist. As in the latter case, the gills are often so attenuated behind that the collar is not at first sight evident.

The pileus varies from white to ochraceous, the number of gills is usually about eight, and the stalk may attain a length of 2 cms. It has the same black spot at the base of the umbilicus, and the same pellicle on the pileus. The leaves are overrun by black rhizomorphic mycelium identical with that on the trees, but the agarics, as a rule, arise from the internal tissues, not from the creeping mycelium. There can be no doubt that this is *Marasmius equicrinis* growing under more ordinary conditions.

More common than the above, in the same situation, is another *Marasmius* which grows similarly on leaves overrun with mycelium indistinguishable from that of *Marasmius equicrinis*. This species is 2–4 cm. high ; its stalk is black and polished, and is about 0·15–0·2 mm. diameter. The pileus is 4 to 6 mm. in diameter, hemispherical, umbilicate, generally with a minute umbo at the base of the umbilicus, rough, radially sulcate with from eight to eighteen rays, yellow-brown, greyish-brown, or ashy. The gills are white or yellowish, eight to eighteen in number, distant, fairly broad, with the lower edge almost horizontal, and united behind into a collar round the apex of the stem. The spores are white, narrow-oval, 8–12 × 3–4 μ. This agrees with the type specimens of *Marasmius rotalis* B. & Br., which, according to the original description, has a pileus with about twelve deep grooves, with sometimes a minute umbo at the base of the umbilicus. Berkeley and Broome describe it as " pulverulent," but the appearance is due to inequalities in the pileus and not to a superficial powder. The cotype at Peradeniya shows the same cord-like mycelium on the leaves, though the agarics arise from the internal tissue. Berkeley and Broome do not mention the collar, but they appear to have recognized its existence, since they state : " This is *M. rotula*, var. *fuscus*, of the Cuban fungi." Their identification of the Ceylon species with the Cuban one may, however, be doubted.

Marasmius rotalis has a pellicle of the same structure as *Marasmius equicrinis*. In the form just described it differs from the latter species in its more numerous gills, more decided collar, and in the stouter, less membranous pileus, which in many instances resembles that of *M. ramealis*, appearing dry

and opaque, instead of being somewhat translucent as is *M. equicrinis* under the same conditions. One is at first inclined to suppose that *Marasmius rotalis* is merely *M. equicrinis* with a stouter pileus and more numerous gills; but as it has never been developed from the tangle in spite of numerous attempts, it must still be considered a distinct species. Berkeley and Broome's cotype of *Marasmius rotalis* at Peradeniya, however, contains both forms, *i.e.*, *Marasmius rotalis*, and *M. equicrinis* as it grows on dead leaves on the ground.

A specimen of *Marasmius equicrinis* consisting of mycelium attached to green living leaves only was gathered on January 23 in the dry season and placed in a glass dish. In the same dish was also placed a piece of mycelium, not more than a foot in length, attached to a dead twig 7 cm. long and 1·5 mm. diameter. In eighteen days a *Marasmius* developed from the mycelium attached to the dead twig, but nothing was obtained from the mycelium on living leaves, though the experiment was continued for sixty-seven days. A similar experiment was instituted on February 15, still in the dry weather; in one dish was placed a large tangle of dead leaves and mycelium taken from the tree about 6 feet from the ground, and in another mycelium attached to living leaves and twigs only. The two were kept side by side. The tangle developed agarics in twenty days, and gave a continuous crop until the experiment was abandoned (March 31); the mycelium which was attached to living leaves when gathered did not produce a single specimen during that time. It appears, therefore, that for the production of agarics (and the continued growth of the mycelium) it is essential that the mycelium should be attached to some dead tissues, into which it can penetrate, and from which it can obtain food. The results of these experiments confirm the view that mycelium is only epiphytic on living tissues.

Although the black "horse-hair" mycelium continues to grow over the dead leaves after the tangle has fallen to the ground, the majority of the agarics then produced arise from the internal tissues of the leaf and break through the epidermis. The mycelium in the decayed leaf consists of very fine separate

hyaline hyphæ ; there is no black cord internally. I have seen instances in which the black cord passed down the centre of a dead twig, but in such the latter was probably hollow from the first. The mycelium, when it enters decaying tissues, becomes quite normal.

It has been suggested that horse-hair blight is spread by birds which use the mycelium in the construction of their nests. If it can be shown that the mycelium is employed for that purpose, the suggestion might be feasible. In Ceylon I have only been able to examine a few nests from the neighbourhood of affected trees, and these did not contain any mycelium. This method of dispersion would not account for its widespread distribution on tea in certain districts, since tea bushes which are interfered with in the course of plucking every three weeks or so are seldom adopted by birds as nesting sites. Further, it would be necessary that the nest be built in a situation where it would be afterwards soaked by the rain. The naturalist of temperate climates will immediately picture the nests of the hedgerows, protected in the summer and exposed in the winter, but he must remember that most of the vegetation in the Tropics—and especially that on which horse-hair blight flourishes—is evergreen, and that in a country where rain falls throughout the year few birds would build a nest in an exposed position. A nest built in such a position that the rain does not then reach it is protected for an indefinitely long period, since there is no universal leaf fall. This appears to throw considerable doubt on the supposition that horse-hair blight is spread by birds.

But it is easy to demonstrate that if the mycelium is transferred from one bush to another it will become attached, if suitable localities are selected. My first experiments attempted to transfer horse-hair blight from nutmeg to tea. The only tea bushes available were ten growing in a single line in an exposed situation and in full sunshine the whole day. The conditions were, therefore, unfavourable. A twig of nutmeg, about a foot long, bearing the mycelium was placed in the middle of one of the bushes in November, 1905, during the wet season. It did not make any new growth, and died in the ensuing dry season. In May, 1906, a similar twig was

placed in a denser bush, and as at the end of the rains (July) it had not travelled to the tea branches, this was regarded as another failure : but in the following wet season (November) it was found that the mycelium had become attached in three places to the leaves and stem of the tea. The delay was no doubt caused by the unsuitability of the isolated tea bushes ; but the case is the more interesting in that it shows that the mycelium on detached branches can survive the comparatively dry months of August (rainfall 6·63 inches) and September (rainfall 2·37 inches). The total rainfall of the dry season (December–March), which proved fatal to the first experiment, was 13·49 inches, and the four months included periods of nineteen, seventeen, and twelve days without rain.

In a further experiment two twigs of nutmeg bearing the mycelium were tied to branches of other nutmeg trees in shaded situations. From the twig which received most " drip " from the overhanging branches the mycelium spread to the new host in nine days. From the other, which was sheltered by a thick cover of foliage, forty-three days elapsed before the mycelium had become attached. The rainfall for the first nine days was 6·25 inches, and for the whole period 13·05 inches. These experiments demonstrate the possibility that horse-hair blight may be spread by pieces of mycelium conveyed with twigs to other bushes by the wind ; but here, again, the growth on tea presents another difficulty in those localities in which it is confined to the interior of a dense tea bush ; for wind-carried mycelium would be arrested at the exterior of the bush, and would be compelled to grow from that position. It seems probable that in spite of these other possible methods, the chief mode of distribution is by means of spores. Spores shed upon a glass slip soon germinate in a damp atmosphere ; indeed, a " spore print " deposited in a closed glass dish usually contains a large number of germinating spores after about twelve hours. But infection experiments made with the spores on the older stems of tea bushes have up to the present been unsuccessful.

It would appear that, since a strand of horse-hair blight has a single definite growing point, it would afford eminently suitable material for the determination of the rate of growth

of a mycelium under various conditions. By placing the mycelium in an Esmarch dish with a little water, it may be determined that growth only occurs if the mycelium is attached to dead tissues ; if a piece of the tangle which contains dead leaves and twigs is used growth may be recorded, but if the piece of mycelium is attached to living leaves only no growth takes place. Attempts have been made to extend this rough observation, but so far without much success. It was found that in the Esmarch dish growth occurred during the first night, and then practically ceased : one series of observations may be quoted :—February 23, 4 P.M., to February 24, 10 A.M., 10·8 mm.; February 24, 10 A.M. to 6 P.M., 0·9 mm.; February 24, 6 P.M., to February 25, 8 A.M., no growth. The following apparatus was then set up :—A horizontal chamber was formed by cementing a sheet of glass to either side of an oval gun metal frame ; the mycelium attached to dead twigs, &c., was laid in this, in a thin film of water on the lower glass. Two thermometers, a wet and a dry bulb, were inserted through openings in the frame, and a current of moist air was drawn slowly through the apparatus. With this arrangement the humidity within the chamber was constant. Measurements were made by observing the position of the end of the strand by means of a travelling microscope. The observations may be summarized as follows :—

Mycelium gathered 3 P.M. ; experiment begun 4 P.M., October 10.

4 P.M. to 5 P.M., Oct. 10, no growth.

5 P.M., Oct. 10, to 8 A.M., Oct. 11, 3·45 mm.

8 A.M., Oct. 11, to 6 P.M., Oct. 11, 0·75 mm.

6 P.M., Oct. 11, to 6 A.M., Oct. 12, 0·6 mm.

6 A.M., Oct. 12, to Oct. 19, no growth.

It is probable that the metal frame may have injuriously affected the mycelium, though the inner side of the frame was waxed in order to avoid that. As no other apparatus was available at the time, the experiment was not carried further, and it has not since been found possible to resume it. But it would seem probable that growth occurs in bursts, and that these are of such short duration that they do not afford much scope for experiment.

Marasmius obscuratus Berk.

Another species of *Marasmius* with similar mycelium has been found in the jungle at elevations from 400 to 2,000 feet. Its mycelium is dull black, and more rigid and thicker than that of *Marasmius equicrinis*. It differs, too, in habit from the latter species. In general, it keeps near the ground, not ascending higher than about 3 feet. Its cords may be long when they are attached to living bushes, but it is more frequently found running over dead branches or twigs near the ground, and in that case the cords are only 10 to 20 centimetres in length. Apparently it does not attach itself to leaves.

The mycelium is cylindric, 0·4–0·6 mm. in diameter. When it comes in contact with living branches, it fixes itself to them by rather large cushions of brown or white hyphæ, which penetrate into the plant and ultimately kill the branch. As a rule, the mycelium does not grow along a branch, but across it. But when it meets a dead branch, either on a bush or on the ground, it disappears into the dead tissue and breaks out again some distance further along the latter. Consequently the tangle on the ground and in the lower parts of the bushes consists of dead twigs united by short lengths of rigid black mycelium. The mycelium within the dead twig is normal; the black rhizomorphic cord breaks up into separate hyphæ when it enters the host tissues. On specimens kept in the laboratory the growing point bore a subglobose, white tuft of hyphæ, but this has not been observed in the field.

A tangle of mycelium and dead twigs was kept on damp soil under a bell-glass for nearly a year. At first it produced only long free strands of mycelium. At the end of nine months several specimens of a *Marasmius* appeared on the dead twigs, but as they were not connected with the black mycelium it was thought that they might be intrusive. A month later, however, the same *Marasmius* developed on the black mycelium.

The pileus is hemispherical, umbilicate, up to 1 cm. in diameter, usually with the margin narrowly re-curved. Some specimens become infundibuliform. It is plicato-sulcate almost to the centre. In the umbilicus it is dark brown,

elsewhere reddish-brown, becoming ashy or brownish-white, streaked with brown fibrils and points. The pileus and gills are dry and somewhat coriaceous. The gills are distant, usually narrow and arched, and united to a disc at the apex of the stalk ; they are at first reddish, then creamy white, rather thick, with the interstices sometimes veined ; they are nearly all the same length. The stalk is up to 1 cm. high and 1 mm. diameter, blackish-brown, rough with minute fascicles of hairs, insititious when growing on dead twigs ; internally it is blackish with a central white core ; it is not horny, but somewhat cartilaginous. The spores are white, narrow-oval, inequilateral, and sometimes curved at one end, 8–10 × 3–4 μ. The pileus is red-brown when dried. This agrees with the type specimen of *Marasmius obscuratus* B. & Br.

Marasmius coronatus, n. sp.

In the jungle at Hakgala one meets with another rhizomorphic mycelium, which occupies the same position as that of *M. obscuratus*, *i.e.*, it is attached to dead or living branches and stems, but not at a greater height than about 4 feet from the ground.

This mycelium is about half a millimetre in diameter, dark brown, except near the growing point, where it becomes white, and somewhat lax. It is closely covered everywhere with adpressed white hairs, and in that respect resembles the mycelium of *Marasmius sarmentosus*. These hairs are simple, up to 0·6 mm. long and 4–6 μ diameter, septate, thick-walled, equal, with the apex rounded, or often irregularly bent at the upper end. The mycelium is united to dead or living stems by a rather large brownish cushion of hyphæ, up to 5 millimetres in diameter, which usually envelops the rhizomorph.

It is most frequently attached to dead twigs, either lying on the ground or still attached to the tree or shrub, but it will adhere to any living stem it happens to meet, apparently without penetrating into the living tissues of the tree. It overruns old stems which have a considerable thickness of bark and evidently penetrates into the latter, as the sporophore develops on the bark without any visible connection with the external rhizomorph. Occasionally it attaches itself to dead

leaves on the ground. As far as has been ascertained the mycelium is not parasitic.

A single strand of mycelium may be traced for several yards, united here and there to anything which comes in its way. But it has also the same habit as *M. obscuratus*, of disappearing into the tissues of a dead branch and breaking out again some distance away, no rhizomorph being discoverable within the branch. The growing end of the rhizomorph tapers to a point which is not protected by any kind of cap.

The mycelium, after running for some distance attached to various twigs, may become erect, if it is not so already, and produce the sporophore at its extremity, or the sporophore may be developed from dead twigs or on the bark of living trees at some distance from the rhizomorph. In the former case the connection of the sporophore with the mycelium is clear, but in the latter it would not be suspected without a previous knowledge of the other mode of development. I have not met with specimens borne laterally on the mycelium.

The pileus is hemispherical, broadly convex, or almost plane, about one centimetre in diameter. The centre is black or dark brown, depressed, usually with a minute conical papilla, clothed with coarse radially arranged fibrils which project in a fringe beyond the margin of the central area. Elsewhere the pileus is brownish-white, with radial ridges of coarse hairs which project over the margin. These ridges are frequently interrupted, so that pileus may appear somewhat concentrically zoned.

The gills are white, crowded, free, and slightly ventricose. The spores are white, narrow-oval, slightly inequilateral, 7–9 × 4–5 μ.

The stalk is 4–7 centimetres high, 0·25–0·5 mm. in diameter, black, dull, not horny, equal, thickly clothed with adpressed white hairs.

The hairs on the pileus are 3·5–4 μ diameter, smooth, simple, thick-walled, flexuose below, separate at the base, cohering above in pointed, tapering fascicles up to 0·5 mm. long.

This species appears to be undescribed, and may receive the name of *Marasmius coronatus*, in allusion to the central

ring of projecting hairs. A variety occurs in which the stalk and pileus are golden brown.

Marasmius coronatus:—Pileo hemisphærico, vel late convexo, vel plano, usque 1 cm. diam.; centro nigro, depresso, umbonato, fibrillis patulis circumdato; alibi brunneo-albido, fibrillis radiatim dispositis, ultra marginem productis, ornato; lamellis albis, confertis, liberis, subventricosis; stipite 4–7 cm., alto, 0·25–0·5 mm. diam., æquali, nigro, crinibus adpressis, albidis vestito; sporis albis, anguste ovalibus, subinequilateralibus, 7–9 × 4–5 μ.

Undetermined Species.

Another species of horse-hair blight which occurs fairly commonly in the jungle at Hakgala has not yet been determined. It is usually found on the bark of living trees, ascending to a height of 40 or 50 feet. It is closely applied to the bark, sometimes running along the fissures, the vertical strands being united by lateral branches, so that the bark is covered with a network of black rhizomorphs. When it reaches the crown of the tree it runs more loosely along the twigs and freely among the foliage from leaf to leaf, forming a tangle similar to that of *M. equicrinis*. Less frequently it is found overrunning low bushes, and in these cases it is apparently parasitic, the hyphæ of the adhering cushions penetrating into the tissues of the plant.

The rhizomorphs are black, glabrous, angular, and somewhat flattened and twisted, from 0·2–0·4 mm. broad; the diameter is not uniform, but varies considerably within a short distance on the same strand. The mycelium is reduced to a fine thread at its extremity.

Up to the present the fructification has not been obtained. Twigs with attached mycelium have been kept under suitable conditions at Peradeniya for more than a year, but, though the mycelium has covered the soil of the pot in which it was kept with a black network, it has not produced any sporophore. In the field a *Marasmius* has been found sparingly, and a *Xylaria* in large quantity on the débris of the crown of a tree infested with this mycelium, which had been felled. But there is as yet no evidence of any connection of the mycelium with

either. The *Xylaria* was included on Plate VII. in the belief that the mycelium pertained to it, but this has not been substantiated.

General Conclusions.

The species which constitute the section *Sarmentosi* of *Marasmius* are characterized by the possession of a black creeping mycelium from which the agaric arises. In the *Insititii* a mycelium of normal structure runs within the leaf or twig, and the stalk of the agaric pierces the outer layers of the matrix and emerges through a distinct hole. But both *Marasmius equicrinis* and *Marasmius obscuratus* demonstrate that these two sections are not mutually exclusive. *M. equicrinis* clearly belongs to the *Sarmentosi* when it develops on the aerial mycelium, and when the tangle falls to the ground it may still retain the same habit; but, in addition, the mycelium breaks up into individual hyphæ when traversing the interior of a dead leaf, and the stalk then bursts abruptly through the epidermis, in which case it belongs to the *Insititii*. If the tangle is cut from the bush and kept moist in a glass dish, both types occur at random. In the case of *M. obscuratus*, the majority of specimens which have been grown from tangles similarly treated have been *Insititii*. The fact that the same fungus may fall into both sections is not new. *Marasmius rotula*, which Fries classed among the *Insititii*, sometimes arises from a blackish creeping rhizomorphic mycelium; and it was placed by Morgan among the *Sarmentosi*. And Theissen has recorded that *M. trichorrhizus* Speg. arises either from rhizomorphic mycelium or independently from twigs.

Nomenclature.

Comparison of the Ceylon species with the *Sarmentosi* recorded from other parts of the Tropics is attended with considerable difficulty, especially when descriptions only are available, because the latter have been described from pilei developed upon the aerial mycelium, and in that situation they are frequently so minute that an accurate description is impossible. Only when the mycelium falls to the ground is a fully-developed pileus produced, and from that situation it has

probably been described under another name. Until each aerial mycelium has been submitted to experiment it is scarcely possible to correlate them.

The horse-hair blights of India and Ceylon have usually been attributed to *Marasmius sarmentosus*, a West Indian species which was described by Berkeley. Recently it has become customary to refer aerial mycelium of this type, even from the West Indies, to *Marasmius equicrinis*, which is an Australian species collected by Mueller and described by Kalchbrenner.

Marasmius sarmentosus was described as " pileo hemispherico, subspadiceo, primum umbonato, *dense sericeo*. margine involuto, demum expanso ; stipite *villo depresso vestito*, demum glabrescente, eximie sarmentoso. Pileus 1–2·5 mm. broad, brown ; stalk thickened at the base, 20–22 cm. long, slender." An examination of the Kew specimens shows that the mycelium is brown, and densely hoary with minute adpressed hairs ; some of the specimens are bright brown, but it is possible that the colour may have been changed in preservation. The pilei are on short lateral stalks, up to 1 cm. in length, and are densely radially fibrillose or shaggy. Berkeley's description is correct, except that the mycelium has been confused with the stalks. Included in the same cover is a specimen of mycelium sent by Hart from Jamaica in 1886 ; this is much thicker and more rigid, and resembles the mycelium of *Marasmius obscuratus ;* it is certainly not *M. sarmentosus*. There is also a Ceylon specimen (mycelium only), labelled *M. sarmentosus*, from the herbarium of Baron von Mueller, which was collected by Thwaites ; this again is, as far as can be determined, the mycelium of *Marasmius obscuratus*.

Marasmius equicrinis was described by Kalchbrenner, under the name of *M. crinis equi* Muell., in Grevillea, VIII., page 153, and again by Berkeley in Jour. Linn. Soc., XVIII., page 383. The description in the former is as follows : " Albido-fulvescens, minimus, Pileo raro, membranaceo, convexo, obtuso (1–2 mm. lato). Stipite (1 cm. et ultra longo), setaceo, rigido, atro, nitido, e mycelio atro, equi crinis similari, assurgente. Lamellæ paucæ, distantæ, pileo pallidiores. The

rhizomorphoid mycelium resembles horse-hair, and is profusely developed, whilst the pilei are very seldom produced. The stems rise at right angles from the decumbent mycelium. The only perfect specimens are in the Berkeley Herbarium, Royal Gardens, Kew."

The second description, by Berkeley, is—

"*M. equicrinis* Muell. Pileo parvo ex umbrino lacteo paucisulcato, e fibris sterilibus repentibus nigris stipiti similis oriundo.

"Dalrymple creek (Lieut. Armitage) : Richmond River (Mrs. Armitage) and in various places, but seldom producing pilei. Nearly allied to *M. tomentillus*, which has very short stems. See Grevillea, Vol. VIII., page 153, where it is called *M. crinis equi*. I, however, follow the original name of Mueller." Mueller's name does not appear to have been published independently, and the strict "legal" name in that case would be *M. crinis equi* Kalch. The majority of mycologists will no doubt prefer Berkeley's version. Examination of the specimens at Kew shows that this is identical with the common Ceylon species. The collar can be distinguished on some of the specimens, and though they are umbonate, they can be matched in this respect by Ceylon specimens of the same size collected on the aerial mycelium. In the same cover is a specimen from Angola, which bears similar pilei, on which the collar can also be detected. Some of the specimens of mycelium from Australia are pale brown, but here, again, it is probable that the colour has been altered in preservation, though it is, of course, possible that this brown mycelium is another species. A specimen from Hart, of Trinidad, included under *M. equicrinis*, has quite a different habit, and is nearer *M. hippiochætes*, though the stalks are glabrous ; it is a collection of stalks, rather than rhizomorphic mycelium.

In addition to the above, the Kew Herbarium contains several specimens of similar mycelium, without any fructifications, from Berkeley's Herbarium, &c. One of these, on tea from Northern India (included with *Stilbum nanum*), is exactly like *Marasmius equicrinis* on tea in Ceylon ; and another collected by Teysmann in Java is indistinguishable from *Marasmius equicrinis*.

It would appear from the examination of the Kew specimens that the common aerial horse-hair blight of the West Indies is *Marasmius sarmentosus* Berk.; at any rate there is no West Indian specimen in the herbarium which can be attributed to *Marasmius equicrinis*. On the other hand, the specimens from Australia, India, Java, and Africa are *Marasmius equicrinis*, and these agree with the Ceylon form.

In " Enumeration des Champignons recoltés à Java par M. Massart " (Annal. Buitenzorg. Suppl. I., 1897, page 107) Patouillard has described and figured *Androsaceus ramentaceus* Pat., which appears to be *Marasmius equicrinis*. I quote the description verbatim :

" *Androsaceus ramentaceus* Pat. (voir., pl. XXIV., fig. 1–4). *Agaricus ramentaceus* Berk. sec. Lev. ap. Zoll. 16 : H. Z. No. 1,144.

" Mycelium rhizomorphoide, glabre, noir, terne, tenace, tres grêle, variant de l'epaisseur d'un cheveu à celle d'un crin de cheval, rameux, long de 30 à 50 centim., formant des touffes laches entourant les feuilles et les petits rameux sur lesquels il s'insere a l'aide de dilatations membraneuses, orbiculaires, larges de ·5 mm. à 1·5 mm. Chapeau convexe, atteignant à peine 2 millim. de diametre, ocrace roux, deprime au centre qui est releve d'une papille obtuse, marque de 5 ou 6 sillons profonds allant du centre à la circonference ; cellules de la pellicule distantes, ovoides ou arrondies, parfois fourchues, échinulees superieurment, pales roussatres, mesurant 6–10 × 8–12 μ ; lames peu nombreuses (5–6), entieres, elargies vers leur partie moyenne, attenuees aux deux extremites, atteignant le sommet du stipe, etroites, un peu plus pales que la face superieure du chapeau. Stipe central, noir, capillaire, aigu vers le haut, peu à peu epaissi vers la base, long de 4 à 5 millim., insere sur le mycelium.

" Le champignon est analogue et tres voisin de *Marasmius equicrinis* Mull. et de *M. trichorhizus* Speg.; *M. Balansæ* Pat., du Tonkin, est plus grand dans toutes ses parties et n'a pas de pellicule specialisee sur le chapeau."

Patouillard does not state that the gills are united behind ; but in specimens from the tangle the gills are generally attenuated behind, and the collar is extremely obscure.

Marasmius equicrinis has a specialized pellicle on the pileus, the cells being simple, up to 20 μ broad, echinulate at the upper end.

Agaricus ramentaceus Berk. is apparently a *nomen nudum*. Léveillé, in Zollinger, "Systematisches Verzeichnis der im Indischen Archipel gesammelten sowie der aus Japan 1842/48 empfangen Pflanzen," p. 16, lists "*A. ramentaceus* Berk., H. 1144. Ad ramos et folia pr. Tjikoya," without any description. This is the reference cited by Patouillard. Zollinger's list was published 1854-55, but the same list of fungi was published previously in Moritzi, "Systematisches Verzeichniss," &c., 1845–46; in the latter the record is "*Agaricus ramentaceus* Berk., No. 1144." In Hooker's London Journal of Botany, III. (1844), p. 329, Berkeley described specimens of Zollinger's collection which had been sent him by Montagne, but he did not describe *A. ramentaceus*, nor is there any description under another name which would apply to Patouillard's species. Berkeley's earlier lists appear to be equally blank, and hence it would seem that the description was never published. The first effective publication of *Agaricus ramentaceus* in this sense is therefore Patouillard's in 1897. There is a previous *Agaricus ramentaceus* Bull., which is an *Armillaria*.

In "*Fragmenta Brasilica*" (Ann. Mycol., Vol. VI., 1908, page 531) F. Theissen re-describes *Marasmius trichorrhizus* Speg. He states that it is identical with *M. equicrinis* Mull., *M. Balansae* Pat., *M. polycladus* Mont., and *M. repens* P. Henn., while *M. Baumanni* P. Henn. is only a variety. The pileus is 0·5–5 mm. in diameter, light to dark brown, flat or depressed in the centre, with or without a papilla; the gills are at first white, very narrow, but generally become brown and broad, even ventricose; the spores are somewhat pear-shaped, 8–13 × 4·5–6 μ. He notes that the fructification arises either from the rhizomorphoid mycelium or independently from twigs.

Rick (Ann. Myc., IX., page 176) also states that *M. trichorrhizus* Speg. = *M. polycladus* Mont.; that *M. Balansæ* Pat. is a form with a larger pileus; and that *M. equicrinis* Mull. and *M. repens* P. Henn. are not "spezifisch verschieden."

I have not seen a specimen of *Marasmius trichorrhizus* Speg., but as Theissen does not mention any " collar," it would appear to differ in that respect from *M. equicrinis*. The identification of *M. polycladus* with *M. equicrinis* is certainly incorrect. A specimen of the former from Montagne, in the Kew Herbarium, arises from rather coarse mycelium, 0·4–0·5 mm. diameter, and closely resembles *M. obscuratus ;* it differs from the latter in having a glabrous stalk.

The type specimen of *Marasmius multiceps* B. & C. at Kew closely resembles that of *M. polycladus*, but it was said to differ in the colour of the pileus, the former being white and the latter brown becoming purple. *Marasmius hippiochætes* was said by Berkeley to be near *M. polycladus*, but the type specimen shows that it is a species with a small pileus and very long stalks, not a species which arises from a rhizomorphoid mycelium, as far as the specimen indicates. *Marasmius tomentellus* B. & C. from Cuba is another species which possesses rhizomorphoid mycelium, but its mycelium is clothed with white spreading hairs, which are apparently deciduous ; it is not *M. sarmentosus*, since the pileus is not shaggy. *M. erumpens* Mass., which was said to be " *M. sarmentoso* affinis," bears no resemblance to that species ; it has no rhizomorphoid mycelium, and its pileus is glabrous.

Without an inspection of the type specimens it is impossible to come to any valid conclusions concerning the other similar species of *Marasmius* which have been described from various parts of the Tropics. The following descriptions are quoted for reference, with some notes which they suggest. The Ceylon and Indian specimens would appear to indicate that the mycelium of any one species is constant in size and appearance.

" *Marasmius trichorrhizus* Speg. Mycelio rhizomorphoideo, gracili, setæ equinæ crassitudine v. vix ultra, rigidulo, glabro, atro, subnitente substrigose ramoso laxissime latissimeque expanso, 20–50 cm. long. et lat., ad corticem ac præcipue in ejusdem rimas repente, hinc inde ramulos fertiles (seu stipites) paucos, breviusculos, 1–2 cm. long., 0·15–0·18 mm. crass., erectos emittente ; pileo hemisphærico, 0·5–1 mm. diam., glabro, obscure testaceo v. rufescente ; lamellis paucis,

stricte pliciformibus, pileo concoloribus ; stipite rigido, erecto v. subflexuoso (in sicco), atro subnitente glabro, levissimo, ad basim non v. minute loniterque annulato incrassato ; ad corticem truncorum putrescentium in silva virginea, Caa-Guazu Brasiliæ. Species ab omnibus adhuc cognitis forma magnitudine mycelii inconsueti distinctissima ; specimina senescentia ac nonnihil obliterata, iterum inquirenda ; an novum genus ? " According to Spegazzini's description, the mycelium grows on dead trunks, not on living branches, and it is closely applied to the substratum, instead of being for the most part free as in *M. equicrinis* : it also differs from *M. equicrinis* in being rather rigid. But Theissen states (*loc. cit.*) that the black tough mycelial cords climb either singly or in clusters up to the crown of a tree, or form thick tangles in the bushes.

" *Marasmius bavianus* Pat. Pileo convexo, dein plano, sulcato, centro umbonato, albido v. fulvo, 0·5–1·5 mm. lato, tenui, pellicula cellulis clavatis, sursum muricatis, subhyalinis obtecto ; lamellis pallidis, parum numerosis (7–8), adnatis ; stipite glabro, setaceo, rigido, lucente, brunneofulvo, supra albido, 2–3 cm. long., $\frac{1}{3}$ mm. diam., sporis fusoideis uno apice obtusis, 10–12 × 3–4. Gregarius ad folia putria in silva Bavi, Tonkin Sinæ. Mycelium rhizomorphoideum lucens, ramosum. *M. aciculiformi* affinis." This species would seem to be near *M. equicrinis*. But a specimen in Herb. British Museum (Balansa, Champignons du Tonkin, No. 106) consists of dead leaves bearing only barren stalks, about 0·1 mm. diam. ; there is no " horse-hair " mycelium.

" *Marasmius Balansæ* Pat. Mycelio rhizomorphoideo, cæspitoso, gracili, 1 mm. cr. (but see below), rigido, glabro, nigrobrunneo, intus albo ; pileo campanulato convexo, margine deorsum involuto, 5 mm. lat., 3–4 mm. alt., brunneo, margine striato ; carne ex hyphis ramosis septatis, centro hyalinis, exterioribus brunneis intertexta ; lamellis distantibus, crassis, parum numerosis, albidis ; stipite centrali, 15–18 mm. long., gracili, rigido, brunneo-nigro, glabro, apice attenuato, 1 mm. cr. Ad ramos arborum, Tonkin, Sinæ. A. *M. equicrini* et *trichorrhizo* quoad mycelium abundans, differt statura majore." This species appears to resemble *M. obscuratus*, from which it

differs, according to the description, in its glabrous stalk. A specimen in Herb. British Museum (Balansa, Champignons du Tonkin, No. 98) consists of a mass of coarse, rather rigid mycelium, 0·35–0·55 mm. diameter; there are no pilei.

"*Marasmius Stuhlmanni* P. Henn. Pileo membranaceo, convexo-plano, radiato-plicato, centro vix umbonato, margine repando-sinuato, pallide cinereobrunneo; stipite setaceorigido, spadiceo-nigro, glabro, curvato e mycelio atrofusco, equi crini similis, assurgenti: lamellis adnatis, valde distantibus, angustis, anastomosantibus, concoloribus. In locis humidis pr. Butumbi, Kjenkesi Africæ centr. Pileus usque ad 1 cm. diam.; stipes usque ad 3·5 cm. long., vix 0·5 mm. cr." From Hennings' figure this species appears to be different from both *M. equicrinis* and *M. obscuratus;* but, on the other hand, the figure does not display any special characteristics. The shape of the pileus differs from that of *M. equicrinis*, being broadly convex and not umbilicate.

"*Marasmius repens* P. Henn. Pileo membranaceo, convexo, explanato, centro depresso, levi glabroque, margine sinuoso-crenato, rufobadio, 1–2·5 mm. diam.; lamellis coloratis, distantibus, paucis (6–8), ventricosis, pallidis; stipite setiformi, corneo, rigido, atro, glabro, subnitente, circ. 1 cm. longo, e mycelio repente rhizomorphoideo, rigidulo, atro, ramoso oriente. Inter folia decidua in Camerunia. *M. trichorrhizo* similis."

"*Marasmius Baumanni* P. Henn. Pileo membranaceo, convexo-explanato, pallide flavo, plicato, centro depresso-umbilicato, papillato, atro, 3–5 mm. diam.; stipite corneo, filiformi, rigido, brunneo, nitente, basi obscuriore, 0·5–2 cm. longo, 0.3 mm. crasso; lamellis coloratis, distantibus, paucis, acie subincrassatis, pallide flavescentibus; mycelio rhizomorphoideo, filiformi, castaneo. In ramis putridis in Togo Afr. Occ. *M. rotulæ* Fr. affinis."

"*Marasmius pallide-sepiaceus* P. Henn. Pileo membranaceo, campanulato-expanso, obtuso, granuloso-squamuloso, pallide cinnamomeo, radiato-striato, 0·5–2 cm. diam.; stipite fistuloso, subcorneo, pruinoso, pallide brunneo, 0·5–1 cm. longo, 1–1·5 mm. crasso, basi discoideo villoso, e mycelio rhizomorphoideo, filiformi, atro oriente; lamellis subtriquetro-decurrentibus, distantibus, ventricosis, pallide sepiaceis;

sporis globosis, 3–3·5 μ diam., hyalinis. Ad ramos putres, Kamerun Afr." The decurrent gills and globose spores distinguish this species from *M. equicrinis*, if the description is correct.

It will be seen that in none of these species are the gills said to be united into a collar round the stalk. Therefore, on that character alone, it might be decided that none of them can be identical with *Marasmius equicrinis*. But, on the other hand, the original description of *M. equicrinis* does not mention the collar, and it is quite probable that the descriptions of the other species may be similarly defective. Exception might be made in the case of *Marasmius trichorrhizus*, which has presumably been examined in the fresh state by several mycologists.

Addendum.

The *Xylaria* figured on Plate VII. was included under the belief that it was the fructification of the undetermined horse-hair blight found at Hakgala. This, however, has not been established.

This species is common at Hakgala on dead leaves in the jungle. It has a black rhizomorphoid mycelium, which usually runs in short lengths from one leaf to another and fastens them together.

The *Xylaria* is produced on the dead leaves, not necessarily in direct connection with the black rhizomorphs. As a rule, several occur together on a single leaf. It varies from 1 to 4 centimetres in height. The stalk is about 0·5 mm. in diameter at the base, smooth, shining, longitudinally striate. The clava is from 5 to 15 millimetres long and about 1 millimetre in diameter; it is either continuous with strongly projecting perithecia, or interrupted with scattered perithecia. Above the perithecia the stroma is attenuated into a hair-like tip of varying length, sometimes 2 to 3 centimetres; this sterile tip may be simple or forked. In some cases growth continues at the tip, which ultimately becomes united to another dead leaf; the clava then resembles a group of perithecia on a long strand of mycelium. One such example is 20 centimetres in length, and bears sixteen perithecia scattered over a length of 14 millimetres.

The perithecia are projecting, with an acute ostiolum; internally they are oval, being flattened in the direction parallel to the clava, and measure 0·5 × 0·3 mm. The asci are cylindric, with a long tapering pedicel, the sporiferous part measuring 68–72 × 6 μ. The spores are black-brown, cymbiform, with rounded ends, 9–12 × 5–6 μ.

In some respects this species resembles *Xylaria filiformis* A. & S., but it is smaller, and its spores differ from those of the available specimens of the latter. It may be named *Xylaria vagans*.

Xylaria vagans n. sp. 1–4 cm. alta; stipite 0.5 mm. diam. nigro, glabro, longitudinaliter striato; clava, 5–15 mm. longa, 1 mm. diam., continua vel interrupta, apice in processu prælongo filiformi producta, peritheciis prominentibus, ostiolo acuto, ovalibus, 0·5 × 0·3 mm.; asci cylindraceis, longe pedicellatis, octosporis, sporis oblique uniseriatis, parte sporifera 68–72 × 6 μ; sporis cymbiformibus, apice obtusis, nigro-brunneis, 9–12 × 5–6 μ; mycelio rhizomorphoideo.

Description of Plates.

Plate II.—Mycelium of *Marasmius equicrinis* on a tea branch: leaves of the tea removed to show the mycelium. × ½.

Plate III.—*Marasmius equicrinis* growing on dead leaves, twigs, &c., developed in the laboratory: about natural size.

Plate IV.A.—*Marasmius equicrinis* developed in the laboratory from the aerial mycelium: natural size.

Plate IV.B.—*Marasmius rotalis*: natural size.

Plate V.—*Marasmius obscuratus*: natural size.

Plate VI.—*Marasmius coronatus*: natural size.

Plate VII.—Fig. 1.—Mycelium of *Marasmius equicrinis* on Nutmeg: natural size.

Fig. 2.—*Marasmius equicrinis* on aerial mycelium: natural size.

Figs. 3 and 4.—Growing points of the aerial mycelium of *Marasmius equicrinis*. × 40.

Figs. 5–7.—*Xylaria vagans*, on dead leaves. × 2.

Fig. 8.—Sterile mycelium of *Xylaria vagans*. × 2.

Fig. 9.—*Xylaria vagans*; longitudinal section of clava. × 8.

Fig. 10.—*Xylaria vagans*; ascus and spores. × 650.

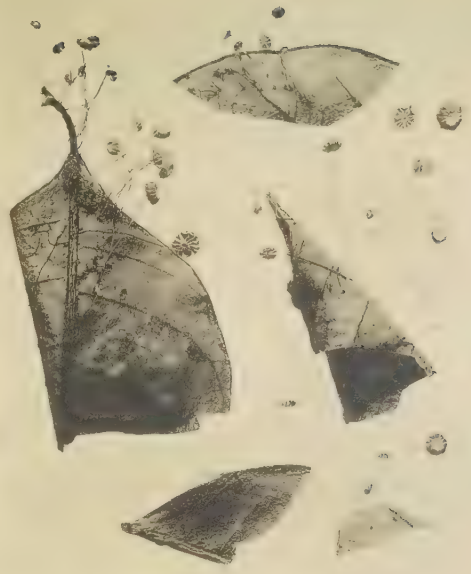
MYCELIUM OF MARASMIUS EQUICRINIS X 1 2

MARASMIUS EQUICRINIS

A

MARASMIUS EQUICRINIS

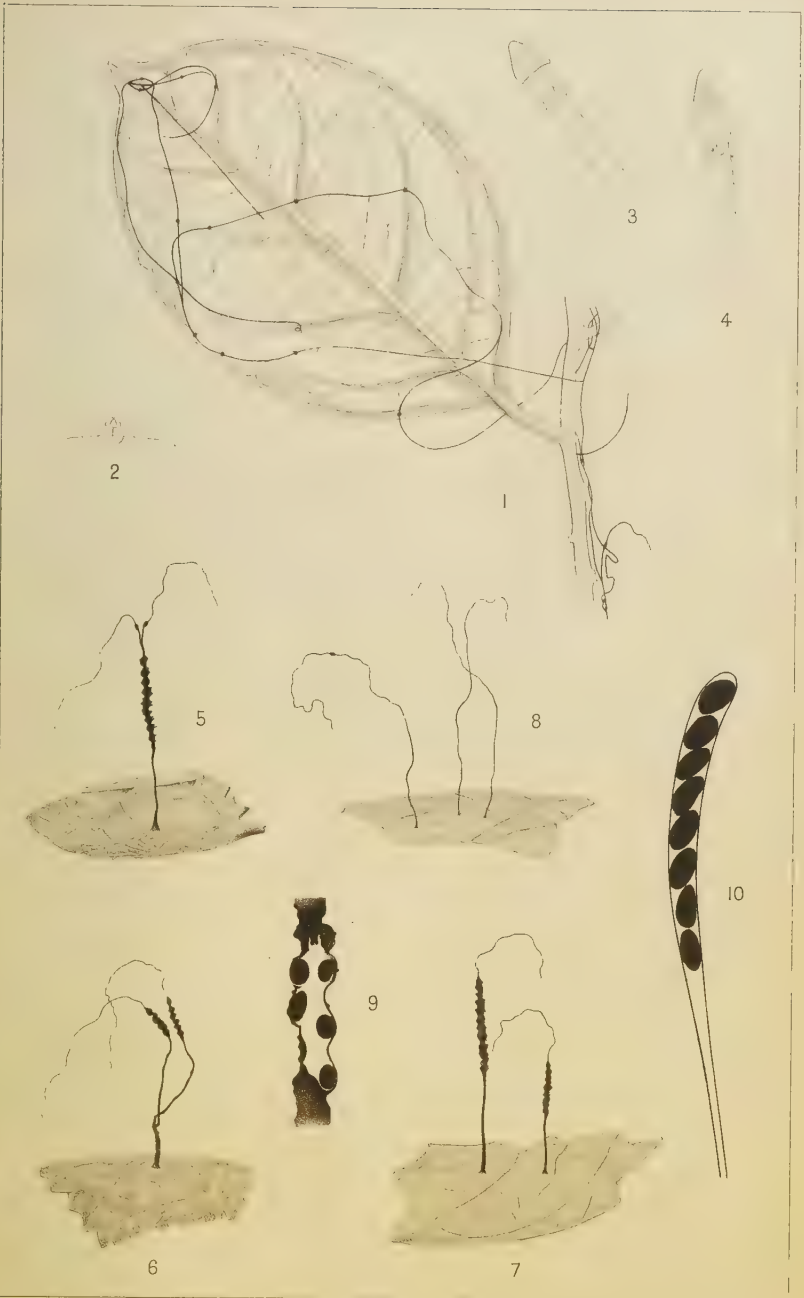
B



MARASMIUS ROTALIS

MARASMIUS OBSCURATUS

MARASMIUS CORONATUS



West, Newman lith.

HORSE-HAIR BLIGHTS.

NOTES.

Centranthera procumbens Benth.—The white variety of this species was collected by Mr. F. Lewis at Hiripitiya, North-Western Province, in February, 1915. In Trimen's Flora of Ceylon "seeds spirally striate" is given as a character of *C. hispida* Br. only; from the herbarium specimens it is a feature common to all the Ceylon species.—T. P.

Sesamum prostratum Retz.—Specimens of this plant were collected by Mr. F. Lewis at Panawa, Eastern Province, where it was common on the seashore, in August, 1914. This is the first record of this species for Ceylon.—T. P.

Ferns.—*Gymnopteris tomentosa* (Lam.) Und., a South American fern, is now common along the roadside from the Botanic Gardens to the Railway Station, and in the neighbouring tea, at Peradeniya; we have no record of its introduction. The common silver fern *Ceropteris Calomelanos* (L.) Und., another American species, has also escaped from cultivation and become established in the neighbourhood of Peradeniya over a wide area.—T. P.

Psoralea corylifolia L.—Specimens of this plant have been sent me by Mr. C. Drieberg from Bodiwela near Lemesuriagama (Walapane district), where it is used as a green manure. Its use for that purpose in Delft was recorded, on the authority of Mr. J. P. Lewis, in Ann. Peradeniya, V., p. 186. The description in Flora of Ceylon and Flora of British India states that the leaves are copiously sprinkled with black glandular dots. That applies to the dried specimens only; on the fresh leaves the glands are green. Flora of British India gives the flowers as yellow; in Ceylon specimens they are purple, as described by Trimen.—T. P.

Liparis Walkeriæ Graham.—This species, which is not uncommon at the edge of the jungle at Hakgala, is said to

have sepals five-veined. In specimens collected at Hakgala the sepals were found to be three-veined, and an examination of the herbarium specimen, C. P. 2376, showed that the same was true of that specimen also. The base of the lip of this species bears two elongated subparallel purple tubercles. The character relied upon for its separation in Trimen's (?) key of the genus, "column long, slender," though true for the dried specimens, is inapplicable to fresh specimens; in the latter the column is about 3 mm. long, and 1 mm. broad in the middle.—T. P.

Mgandamalej.—In an article on "*Bidens Chinensis* (L.) Willd. und verwandte Arten" (Engler's Bot. Jahrb., Bd. L. (supplement), pp. 176–187), O. E. Schulz states that specimen No. 15023 in Herb. Willdenow, named *Bidens Chinensis* Willd., was collected by Klein on February 29, 1796, at Mgandamalej in Ceylon. As Mgandamalej is evidently not a Ceylon name, this record appeared doubtful, but the puzzle was solved by Trimen (Flora of Ceylon, iv., p. 27), who wrote as follows with regard to a similar record of *Blepharispermum petiolare* DC.:—"The original specimens were collected 'Prope Uganda-malej' on '29 February, 1796,' Wight says by Klein; but this is apparently an error for Rottler, who travelled down our East Coast in that month and year. The place is now called Ukanda. The specimens, however, are no longer in Rottler's Herbarium, having been, as in some other cases, probably transferred to Klein's, who was also a member of the Tranquebar Moravian Mission."—T. P.

Lastræa sparsa var. undulata.—In Wall's catalogue of the ferns indigenous to Ceylon this variety is said to be confined to the upper part of Wattakelle Hill. Beddome, in "The Ferns of British India and Ceylon," states that it is only found on the top of the hill over the Hakgala Government Gardens; this is apparently in error, as we have no specimens in the Herbarium from that locality. Some years ago this variety was discovered by Mr. T. Farr near Wettanagala Peak, 12–14 miles east-south-east of Adam's Peak; and specimens collected in Maskeliya have recently been received from Mr. R. Maclure. —T. P.

New Aliens.—*Veronica serpyllifolia* L. is now common along the golf links at Nuwara Eliya (April, 1915). *Prunella vulgaris* L. is well established at Nuwara Eliya in drains by the roadside (April, 1915). A form of *Sonchus arvensis* is now well established up-country, and during the last few years has spread to medium elevations. It was not collected by Thwaites or Trimen, nor by Willis and Smith in their investigation of the up-country flora in 1906. In 1912 the writer noted it in abundance below Haputale, along the road to Haldummulla. During the last two or three years it has sprung up in considerable quantity on the "made" ground round the new museum in the Botanic Gardens, Peradeniya, and still persists there. It was not sent in from any estate during the inquiry into the presence of weed seeds in manure in 1912–13.—T. P.

Native Names for Plants.—*Mollugo nudicaulis* L. is known as "Kawudu-tirar" at Okanda, Eastern Province, *fide* F. Lewis. The Water Hyacinth (*Eichhornia crassipes* Solms.) has received the name of "Japan Yabara" in the Tangalla district, *fide* W. E. Wait. *Mikania scandens* Willd. is known as "Mokattu" T. (veil creeper) in the Trincomalee district. Mr. C. Drieberg points out that the Sinhalese name of *Jatropha Curcas* is not "Rata-endaru" as given in Trimen's Flora of Ceylon, p. 46, but "Wata-endaru" (wata = hedge). From the Southern Province *Uvaria Narum* Wall. has been received, with the information that it is called "Pangan." *Andropogon aciculatus* Retz. has been sent in with the names "Pitinei Pillu" T., "Bin Thanakola" S., and "Ambagamuwa Grass." From the Elkaduwa district Dr. C. M. Thomasz reports that *Achyranthes aspera* L. is known as "Navarangi Ella" T., *Leucæna glauca* Benth. as "Vada Raja" T., *Jatropha Curcas* L. as "Son Cotta Ella" T., *Vitex Negundo* L. as "Ang-ela Nutchi" T. and "Nika Korla" S. *Symplocos spicata* Roxb. has been sent in from the Gampola district under the name of "False Tea Plant."—T. P.

Eulophia.—The key to the genus *Eulophia* in Trimen, Vol. IV., p. 175, appears to have been badly "pied" by the printer. According to it, *E. macrostachya* has a tuberous

hypogeal rootstock, and its column is not produced into a foot, but the description of that species correctly states that its column is produced into a very short foot and that it has a pseudo-bulb. The key would appear to require re-arranging as follows :—

Column not produced into a foot—
- sep. linear oblong, acute or obtuse .. *E. virens*
- sep. lanceolate, acuminate .. *E. graminea*

Column produced into a foot—
- Pseudo-bulb epigeal .. *E. macrostachya*
- Rootstock tuberous, hypogeal—
  - L. and fl. produced together .. *E. nuda*
  - L. produced after flowers .. *E. sanguinea*

Alternatively the primary division may be made to depend on the presence of an epigeal pseudo-bulb in the first three species.

The difference (in the key) between *E. nuda* and *E. sanguinea* is not constant ; the flowers of *E. nuda* may appear before or at the same time as the leaves. The statement that the sepals of *E. nuda* are connivent " at the base " should be " at the apex," but this character is not universal.—T. P.

Blumea amplectens DC.—The C. P. specimens of this species appear to have been considerably mixed. In Herb. Peradeniya, C. P. 1730 is *B. amplectens*, and *Erigeron asteroides* Roxb., C. P. 1732 (2 sheets) is *Blumea bifoliata*, and C. P. 3523 (marked in pencil, also marked 1730) is *B. amplectens* and *Erigeron asteroides*. Clarke, Compositæ Indicæ, states that C. P. 1732 is *Blumea amplectens*, and C. P. 3523 is *B. bifoliata*. Flora of British India gives C.P. 1730 (in part) as *B. amplectens* and C. P. 3523 as *B. bifoliata*. Trimen's Flora of Ceylon gives C. P. 1730 and 1732 as *B. amplectens* and states that C. P. 3523 is not in Herb. Peradeniya. In Trimen's Flora the achene of *B. amplectens* is said to be very small, oblong, compressed, three-ribbed ; this description is evidently taken from C. P. 1730 and refers to *E. asteroides ;* the fruit of *B. amplectens* is purple-brown, oblong, not ridged, covered with white

adpressed hairs, and with a crown of minute hairs at the apex.—T. P.

An abnormal Clathrus Egg.—Five eggs of *Clathrus crispatus* were gathered at Hakgala in 1914. All appeared to be normal, but when they expanded one of them proved to be double.

The surface of the egg of this species is marked with a network of lines which correspond in position with the meshes of the net. Between the lines it is swollen, so that the surface consists of a series of tubercular elevations. These swellings at the top of the egg are roughly hexagonal (in plan) and about a centimetre broad, but those which run down to the base are much larger and elongated. A figure of the normal egg was published in the Annals of the Royal Botanic Gardens, Peradeniya, Vol. IV., Plate xiii. When the egg is mature, but not expanded, the receptaculum forms a compact sphere in the centre, surrounded by a thick layer of jelly, and the tubercular swellings contain jelly only.

In the present case the diameter of the egg was 8 centimetres. The central receptaculum was quite normal, but one of the surface swellings situated near the base contained an additional receptaculum. The elongated tubercular area was 4·5 centimetres long and 2·5 centimetres broad, and the miniature receptaculum nearly filled this space.

This additional receptaculum was separated by a layer of jelly from the normal receptaculum in the centre, and sprang from the outer wall of the egg at a node of the superficial network. As it was not separated from the main egg by any layer corresponding with the outer wall of the egg, it was not a case of the fusion of two eggs which originally arose independently, but close together, from the mycelium, as so often occurs in *Dictyophora*.

The abnormal receptaculum was laterally compressed. Its lower half formed a funnel, 1·5 centimetre high and 1 centimetre diameter above, which divided into the five primary arms of the net. On one side the funnel was continuous, except for a single perforation, but the other side was netted almost to the base. The arms of the net were 1·5–3 mm. broad, and the number of meshes in the upper part of the net

about nine. It may be noted that in normal specimens of *Clathrus crispatus* the arms of the net are 2–2·5 cm. broad. The receptaculum did not differ notably from the normal, except in its small size and in the absence of any gleba.

Doubling of the receptaculum within a single egg is fairly common in *Simblum periphragmoides* (see Annals, Peradeniya, IV., p. 167 ; V., p. 13), though in the cases observed both the stalks arise from the base of the egg. This is the first time I have met with the phenomenon in *Clathrus*.—T. P.

Beetles and Fungi.—In Jour. Linn. Soc. XVI., p. 41, Berkeley recorded the presence of a fluffy mass of insect dung on *Hirneola rufa*. The note, which runs as follows, is apparently one made by the collector of the specimens during the "Challenger" expedition :—"These fungi were all found in the dry condition, being collected in the dry season. Some are attacked by an insect larva, whose dung takes the form of a curious fluffy mass."

Similar occurrences of a loose fluffy mass on the more persistent species of fungi, *e.g.*, *Polyporus*, *Fomes*, *Hexagonia*, &c., are common in Ceylon. These masses are composed of rather rigid curly threads, about 0·1 mm. diameter, loosely intertwined, and resemble a handful of curled horse hair. The colour varies according to the fungus. On *Polystictus Persoonii* and *Polypori* of similar context it is white or yellowish ; on *Fomes australis* it is yellowish brown ; on *Hexagonia apiaria* and *Hirneola hispidula* it is red-brown.

After numerous discussions with several entomologists who insisted that no insect could produce such a structure, it was found in course of formation on an extensive growth of *Polyporus secernibilis* in my garden at Peradeniya. From the *Polyporus* several beetle larvæ were isolated, and these were kept under observation in glass dishes in the laboratory, being fed with *Polyporus secernibilis*, or *Lentinus subnudus*, or *Polystictus flabelliformis*. When placed on the under surface of the fungus the larva immediately began to eat, and almost simultaneously the white filament began to issue *ab ano*. There was, therefore, no possible doubt that the fluffy mass was produced by an insect. Apparently the filaments are produced

continuously as the larva eats. As a rule, the larvæ feed on (or near) the surface of the fungus, and the fluffy mass of dung may serve as a protection.

To obtain the beetle the pieces of *Polyporus* on which the larvæ were feeding were placed on sterilized (baked) soil in glass dishes. As a further check several larvæ were transferred to similar dishes containing pieces of *Polystictus flabelliformis*, which had also been baked. The beetles emerged in about three weeks after the larvæ had gone to earth. Of 135 beetles obtained in these dishes, 118 were *Ceropria induta* Wied., and 16 *Toxicum oppugnans* Walk. The remaining beetle was a smaller species; it has apparently been mislaid, but, like the two already mentioned, it was a *Tenebrionid*. Possibly the habit of producing a fluffy mass of dung is common in that group, though I have not been able to find any reference to it, nor to meet any entomologist who was aware of it. But the specific name of the *Ceropria* suggests that it was known to the describer of that species.—T. P.

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